AN EVOLUTIONARY APPROACH TO FARMING DECISION MAKING ON EXTENSIVE RANGELANDS

By

GUSTAVO FERREIRA

A thesis submitted for the degree of
Doctor of Philosophy

Institute of Ecology and Resource Management
University of Edinburgh

June 1997

I dedicate this work to the memory of my father, the support of my mother and the patience and comprehension of my wife and children.

"What we have to learn to do we learn by doing" (Aristotle).

Declaration

I hereby declare that this thesis has been composed by me and that all work presented in the thesis is my own unless specifically otherwise stated

September 21, 1997

Abstract

Title: An Evolutionary Approach to Farming Decision Making on Extensive Rangelands.

Author: Gustavo Ferreira

In more than 25 years, a simplistic model of farm decision making has been used to support agricultural policy, research and extension without considering socio-economic and environmental sustainability. The basic assumptions of policy development were based on an "average farmer" and the marginal value of money completely ignoring the marginal social value. This research claims the need of a more holistic "model" of decision making at farm level, where i) behaviour diversity is recognised in farmers' populations and ii) the dynamic and evolutionary interrelationships between the farm, the farmer, the family and trusted people as a unit of resource allocation, are considered.

The objectives of this work are to: i) improve the understanding of the decision making process at farm level ii) develop decision concepts for research and extension agencies and policy makers and iii) demonstrate that rural peoples' knowledge plays an important role in development.

A selective review of the main approaches and of descriptive models used to analyse decision making, a survey and a case study analysis is undertaken in order to develop: i) a conceptual background for classifying decision making units into different behavioural Types and ii) to develop a general "model" of the structure of the farm decision making unit's "natural" decision support system actually used by farmers. Multivariate techniques were used to establish and validate the classification. Several implications for policy makers, information generators and data transmitters underlying the study were identified.

Key Words: Decision making, Decision Support Systems, Farmers Classification, Recommendation Domains, Conceptual Modelling, Multivariate Statistical Analysis, Cases studies, Farm Family Business, Rangelands, Extensive Livestock Production Systems, Uruguay, Basaltic Agroecozones.

Acknowledgements

Without the support of a large number of people and institutions, the present work would not have been possible, and whilst I can not name them all, I remain indebted for any help received. I would like to acknowledge this and express my gratitude for all the advice, help and support I have received.

I would particularly like to express my deepest gratitude to my supervisor, Professor J.B. Dent, who went far beyond the call of duty in providing advice and close supervision throughout the development of this thesis. Comments and continuous enthusiastic encouragement throughout the study and whose assistance in obtaining financing for the study, can not be overestimated. I would also like to express my sincere thanks to Dr. Bruce Currey, Dr. Murray McGregor, Ing. Agr. Néstor Eulacio, Dr. Samita Sembakutti, Ing. Agr. Walter Oyancabal, Mrs. Sandra Dent, Mr. Salman Hussain, Mr. Oliver Morgan, Mr. Alister Sutherland, Ing. Agr. Mario Allegri, Mr. Alister Kyd, Mr. Ronnie Mcintyre, Ing. Agr. Pedro Arias, Ing. Agr. Diego Risso and Dr. Gareth Edwards-Jones; for their support and helpful comments.

I am also acknowledging the encouragement and financial support of the National Agricultural Research Institute (INIA Uruguay), in particular the following members of the Institution: Ing. Agr. José Miguel Otegui (deceased) and Mr. J.P Hounie (Former INIA presidents), Ing. Agr. Marcial Abreu (Former INIA Boardmember), Ing. Agr. Roberto Symonds (INIA Boardmember), Ing. Agr. Raul Leborgne (Former INIA Boardmember), Ing. Agr. José Silva (Director of INIA-La Estanzuela), Dr. Gabriel Cerizola and Mrs. Alejandra Guerra (Human Resources Unit) and Ing. Agr. John Grierson (International Unit). My very special thanks to the Director of INIA Tacuarembó, Dr. Carlos Paolino and the former Director of INIA Tacuarembó Ing. Agr. Oscar Pittaluga for their comments, encouragement and support during the execution of the project in Uruguay.

I would like to express my gratitude and sincere thanks to the Overseas Development Administration and The British Council for covering the costs of this research in the

United Kingdom, particularly to Dr. Harry Potter, Mrs. Carla Piaggio, Mrs. Monica Paterson and Mrs. Maria Mercedes Frugoni for their invaluable aid and assistance.

I am greatly indebted to all the farmers and their families who agreed to be interviewed and patiently responded to all the questions in my large questionnaire, especially the case study farmers. They willingly shared their generous and amiable knowledge, experience and details of their life and work as farmers thus providing the study with invaluable information. My sincere gratitude and thanks to Mr. Juan Dutra Da Silveira, Dr. Leopoldo Amorin, Ing. Agr. Federico Lalanne, Mr. Nery Omar Ibarra, Ing. Agr. Ramiro Azambuja and their families.

I would like to thank all the personnel of INIA Tacuarembo who have supported my work, particularly Dr. Ing. Elbio Berreta, Ing. Agr. Fernando Olmos, Ing. Agr. María Bemhaja, Ing. Agr. Guillermo Pigurina, Dr. Fabio Montossi, Bibria. Gloria Abero, Mrs.Graciela Navarro and Mrs. Cristina Gaggero for their comments about the questionnaire and support during the survey. Moreover, I would like to express my gratitude to Ing. Agr. Eduardo Grasso and Ing. Agr. Jorge Lena of the Plan Agropecuario extension services for facilitating work by introducing me to the farmers.

I really appreciate the support and friendship of my fellows and friends at the University of Edinburgh, particularly: Mario Herrero, Vicente Silveira, Ivo Cezar, Alison Brand, Isilda Nhantumbo, Angela Treagar, Jo Traill-Thompson, Alberto Bernues, Juan Busque, Salvador Hernández, Alfredo Albin, Eduardo Loedel, Subhash Babu, Sandra Stewart, Kate Corcoran, Jane Grandison, John Finlayson, James Wright, Tim Perkins, Kenneth Nkowani and Yu-Lin. My very special thanks to Linda Goodall.

I would like to recognise and acknowledge Mrs. Miriam Posadas and Ms. Lucila Roper for helping me with my English.

I would like to thank my disappeared dear friend and colleague Alfredo Estradé and his family, with whom we started working in agricultural systems a long time ago.

My most sincere and extremely grateful thanks to my parents, for all their permanent and kind encouragement, education and support. To my brothers, sister, and relatives my very special thanks for their assistance and help.

Lastly, I wish to express my deepest recognition to my fond wife Silvia for her permanent support, patience and trust, who together with my beloved children Santiago, María, Lucia and Nelson, have coped admirably with my absences and long hours of work.

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List of Abbreviations

AIS	Agricultural Information Systems.
AKIS	Agricultural Knowledge Information Systems.
BCU	Central Bank of Uruguay.
CEPAL	Economic Commission for Latin America.
CIAAB	Agricultural Research Centre "Alberto Boerger".
CIDE	Commission for Investment and Economic Development.
CIVET	Veterinary Research Centre.
DICOSE	National Office for Livestock Control.
DIEA	Direction of Agricultural Economic Research of the MGAP.
DSS	Decision Support Systems.
EU	European Union.
ELPS	Extensive Livestock Production Systems.
FD-MU	Farm Decision-Making Unit.
FF	Farmers First.
FSR	Farming System Research.
FSR/E	Farming Systems Research and Extension.
FUCREA	Regional Centres for Agricultural Experimentation (Uruguay).
GATT	General Agreement on Tariffs and Trade.
GDP	Gross Domestic Product.
GLA	Grazing Land Decision Support Application.
GNP	Gross National Product.
IDH	Human Development Index.
INIA	National Agricultural Research Institute of Uruguay.
IT	Information Technologies.
ITK	Indigenous Technical Knowledge.
MERCOSUR	Southern Cone Common Market.
MGAP	Ministry of Agriculture, Livestock and Fisheries of Uruguay.
MSK	Modern Scientific Knowledge.
NAFTA	North American Free Trade Agreement.
NM	New Zealand Model.
NS	No significant.
OFR	On-Farm Research.
OPP	Office of Planning and Budget of Uruguay.
OPYPA	Office of Agriculture Policy and Planning of the MGAP.
PA	Agricultural Plan.
PLAN	National Honorary Commission for Planning Agricultural Development of Uruguay.
PPP	Purchasing Power Parity.
PR	Participatory Research.
PS	Production Systems.
R&D	Research and Development.

RPK	Rural People's Knowledge.
RSG	Ranch Systems Group.
SAS	Statistical Analysis Software.
SEPLACODI (Uruguay).	Secretariat of Planning, Coordination and Diffusion
SPSS	Statistical Package for Social Sciences.
SR	Systems Research.
SSA & C	Stock and Station Agencies and Clerks.
TOT	Transfer of Technology.
UK	United Kingdom.
UNDP	United Nations Development Programme.
WTO	World Trade Organisation.

Chapter 1
Introduction and Background

1.1. General Considerations

Concern about the sustainability of environmental and economic systems has been mounting during the last decade (Sariskandarajah *et al.* 1989; Moonen 1996). Never before has the rate of change been so rapid. The integration and transfer of knowledge are promoting a revolution in technical and scientific spheres, a process spurred by this concern and by information technology (McCalla 1994).

These changes have direct impact at economic levels and are prompting governments to introduce changes in order to develop the conditions for sustainable growth and improvement in welfare. At a macro level, policies are being adopted which have direct and indirect effects on agriculture (for instance, free-trade block agreements, privatisation of production services such as research and extension, and budget reductions in government activities) (Berdagué and Escobar 1994). These polices are constructed on the basis of the dominant ideology, the availability of technology and the general conceptualisation of the main problems and their possible solutions. Such policy decisions are usually made without the participation of all the affected economic actors. The dominant ideology is like "waves of thinking" that start to expand in society, creating the accepted viewpoint at that point in history.

Taking as a reference these economic policies deriving from the main external and internal "waves of thinking" of the scientific world, the research and extension complex develops the corresponding strategies.

During the 1960s, the "Green Revolution" package was spread in the developing world by the International Research Centres (Pomfret 1992). This package was reinforced with Schultz's conceptions (Schultz 1965; 1968) of the promotion of technical change in order to modernise agriculture in undeveloped countries (Dasgupta 1995; Hayami and Ruttan 1985). The idea was that the introduction and expansion of high productivity technologies based on high levels of inputs and efficiency would lead to agricultural development in developing countries. The basic problem was deemed to be the low productivity of land and labour in the agricultural sector of developing countries (Pinstrup-Andersen 1982).

Along the same line of thinking, a model for Research and Transfer of Technology [TOT] was developed under the assumption that the research product was scale neutral (Norman 1978; Hildebrand 1986). This implied that the results from agricultural research, oriented around high productivity, would be equally adoptable on both large and small farms. The model as conceived was simple, linear.

> *"Development is seen as a modernising force or process, one which acts to transform traditional practices. The superiority of "rational science" is assumed and the pursuit of change is derived almost exclusively from the findings of the research station and transmitted to the farmer through hierarchical, technical oriented services and farmers are therefore seen*

as "adopters" or "rejecters' of technologies" (Scoones and Thompson 1994).

A simple model of economic rationale has been developed from this concept, one that implies that farmers' decisions are driven mainly by two forces:

• income maximisation.

• risk minimisation.

Discussion was focused on technical efficiency and on generation and transfer of knowledge (Dent 1995). The Green Revolution package had different impacts in different parts of the world. Despite the success in increasing agricultural outputs, some valid concerns have arisen :

• agricultural output has been increased at the cost of even greater income inequality (Whyte 1986; Hildebrand 1986; Röling 1988; Pomfret 1992; Chambers 1993; Corcoran and Dent 1994).

• expanded production has caused reduction in food prices and, consequently, in farmers' income (Woolhouse 1994).

• local knowledge systems (rural people's knowledge) were ignored and replaced by technical expertise and foreign concepts (Botchway 1993; Chambers 1993; Portela 1994).

• an increased dependence upon purchased inputs arose, with the associated need for credit (Hildebrand 1986; Pomfret 1992).

• an increased use of fertilisers, pesticides and herbicides has lead to pollution and detrimental ecological impacts (Duffy 1991; World Bank 1992).

• There has been an increase in the demand for energy in the agricultural sector (Pomfret 1992).

• There are long-term concerns about the narrow genetic base of the high yield varieties (Pomfret 1992).

The main elements of "Green Revolution" concepts are still used in International and National Centres in order to prioritise research and extension policies. There is a strong resistance against change (Chambers 1989). The long-term effects of the application of these policies are going to be felt more strongly in the 1990s.

> *"deleterious social impacts are irreversible, while many environmental impacts are costly to correct"* (Dent 1994).

The soil resource is more easily eroded through the application of intensive farming systems by reducing organic matter content. These systems are thus more profitable in the short term but not necessarily environmental sustainable in the long-term (Dobbs, Smolik and Mends 1991). The main concern now is to find ways to increase productivity and efficiency at farm level while minimising the effects on the socio-economic and ecological environment. The environmental and socio-economic perspective must be focused upon achieving sustainable growth.

A recent study (Dent 1995) shows that the main explanatory factor in the low adoption rates of new technology is the scientific community's lack of understanding of the farmers' decision-making process. The lineal model of TOT ignores farmers' rural people's knowledge, creativity and the main informational sources used in order to make-decisions and manage the farm (Röling 1993). Recognising the need for a more active integration of farmers in the research-extension complex has led to new concepts such as Farmers First [FF] (Chambers 1989), Farming Systems Research [FSR] (Hidebrand 1986), On-Farm Research [OFR], Participatory Research [PR], Agricultural Information Systems [AIS], and Agricultural Knowledge Information Systems[AKIS] (Röling 1988). Today, it is widely recognised that agricultural systems in Latin America and Europe are greatly influenced by the fact that most production units are family businesses (Corcoran and Dent 1994; Errington and Gasson 1994; Alonso and Pérez Arrarte 1982).

> *"It is an undeniable fact that there is a large socio-cultural component in the adoption of any policy or technology"* (Dent, Edward-Jones and McGregor 1994).

> *"Therefore, decisions at farm level are going to be strongly affected by the socio-cultural context"* (Dent, McGregor and Edward -Jones 1994).

Consequently, a better understanding of the inner mechanisms of decision-making at farm level and the agricultural policy/research output/extension complex inter-relationship is crucial in order to provide clear guidance on the development of rural policies and on priority-setting for the research and extension complex.

> *"A better understanding of the basic characteristics of farmers' families and the way these impact on the Farm Decision-Making Unit (FD-MU) is likely to be fundamental to improve policy formulation and the "delivery mechanisms" for such policies"* (Dent 1994).

The new economic scenario is forcing farmers, extensionists, researchers and policy makers to consider the validity of existing concepts.

> *"Social well-being is an aggregate of individual well-beings, even when decision units are multi-membered households. Governments need to be conscious of the household as a resource allocation mechanism"* (Dasgupta 1995).

By better understanding the decision-making process and the decision support systems used at farm level it should be possible to increase both productivity and the socio-economic and environmental sustainability of the systems. The development of conceptual models that can reinforce farm management activity through a more efficient use of information can lead to an improvement in decision-making at farm level.

The aim of this work is to better understand the process of farmer decision-making, and the dynamics and the interaction within the family and with other surrounding people in order to develop a conceptual model that can be better used to target the research and extension complex. Special reference will be made to circumstances in Uruguay.

The methodology developed in this research, comprises the following steps:

- secondary information analysis,
- questionnaire and survey development,
- descriptive statistical analysis,
- information reduction through principal components factor analysis,
- FD-MUs classification using cluster analysis and "types" description,
- validation of the "types" obtained by the use of discriminant analysis,
- FD-MUs decision support model development,
- in-depth case study for one selected farmer of each of the "types" obtained.

Two major surveys were carried out in order to study and characterise the different farm-family systems on the Basaltic soils of Uruguay. Variables relating to socio-economic, decisional, informational, and productive aspects were explored. Following the analysis of the survey's data, three main groups of farm-family systems were identified. The defined groups were considered to represent different farm-family decision-making systems.

Since this classification was based on two surveys that represent two moments in farm-family history, it has not been possible to substantially improve the understanding of the dynamic elements in the decision process from these data alone. In order to do so, one farmer from each group was selected as 'typical' and an in-depth case study was carried-out. Afterwards, a descriptive "model" was developed for each case to represent the main features of the farm-family decisional systems.

These conceptual "models" of decision-making at farm level provide information about the different routines used by the farm-family units and their "trusted people" in their search for information, the acquisition of knowledge, the processes and analysis used to support decisions. The level of adaptability and response to changes in the working environment depends on the characteristics of the farm decision-making unit. The evolutionary economic approach (Nelson and Winter 1973; 1974; 1976; 1982; Andersen 1994; Leydesdorff 1994) provides a different explanation for technical change. According to this approach,

> *"Farmers rationality is not based on optimisation, but rather on heuristic routines or conventions"* (Possas 1989).

Empirical evidence demonstrates that this non-neo-classical approach provides a model that better describes farmers' actual behaviour. An evolutionary approach appears to be more suitable as an explanatory tool in evaluating technical changes, and in understanding the micro dynamics of decision-making at farm level.

1.2. Thesis Overview

A description of global changes and Uruguay's main features especially focused on the agricultural sector is presented. In order to introduce the study, data about the country's general features, such as population and other economic indicators, are presented in Chapter Two, as well as the main features of extensive livestock production systems [ELPS] which are largely found in the land area of Uruguay.
An overview of the main approaches and models developed in order better to understand decision-making at farm level is presented in Chapter Three and Four. Concepts related with "natural" and "artificial" decision support systems, the objectives and the hypothesis selected for the study are presented in Chapters Five.

A description of the main aspects related with the methodology: questionnaire, sample definition, data collection and survey development, and the main elements of field work are presented in Chapter Six. The main results of the survey and the description and analysis of the main socio-economic, decisional, behavioural and informative variables of the survey are also presented together with the farmer's socio-economic, family and farm characteristics.

Farmers' classification is carried out based on the descriptive analysis of variables in the survey. The classification was done using principal components analysis in order to reduce the number of variables and cluster analysis. The main informative and decisional features of each group of farmers is elucidated. The classification obtained is validated using discriminant analysis. The descriptive analysis, farmers classification and the features in each cluster are presented. Finally, a conceptual model is elaborated based on the analysis developed in Chapters Six and Seven.

In order to better understand the micro dynamics and deep elements of the decision-making process, three case studies are shown, the method, analysis and main results of which are described in Chapter Eight.

The main implications, conclusions and recommendations generated by this study are presented in Chapter Nine. Particular emphasis has been placed on policy development and delivery for the extension research complex operated by INIA Uruguay.

Chapter 2

Global Changes and main features of the country

2.1. Introduction

It is now generally recognised that the interaction between the decision-maker and the environment is an important one. How the decision-maker behaves is strongly affected by both the working environment and the point in time when the study is carried out. Therefore, it is necessary to ascertain the main features that may affect the process under study. Farmers are studied as decision-makers operating within an external framework which incorporates socio-economic and environmental variables. It is therefore necessary to contextualize this study in order to adequately set-up the problem for analysis (Skerrat and Dent 1994).

First, some relevant tendencies in the world's economy are considered briefly, and then, a description of the working environment of the country where the study was developed is presented.

2.2. Global Changes

2.2.1. Economic globalisation

A series of transformations have taken place over the past few years that have dramatically changed the world's economy (World Bank 1995). Globalisation has influenced international development as well as key corporate functions including production, marketing, and research and development [R&D](Howells and Wood 1993). Competitiveness is no longer explained only in terms of the advantages derived from the availability of natural resources and capital, but in terms of technology, innovation and knowledge which are the new basis for competitiveness (Villanueva Lara 1987; Tapscott 1995). These changes are mainly the product of new possibilities provided by technologies like electronics, telecommunications, informatics and biotechnology that permit the establishment of communication networks of and economic power. The latter facilitate trade and business management, and the transfer of financial and intellectual capital throughout the world (Howells and Wood 1993; Laudon, Traver and Laudon 1994). The economic, social, ecological and technological bases used by the agricultural sector have been changed in an irreversible way. The goal of finding a new economic alternative leading to socio-economic sustainable growth is no longer a problem concerning undeveloped countries alone; it is also a problem which concerns developed countries as well.

2.2.2. Environmental Problems and Globalisation

Economic policies in the past gave inadequate attention to environmental issues. Consequently, the current level of environmental degradation is serious at world level (World Bank 1992; Rodenburg, Tunstal and van Bolhuis 1995). The warming up of the planet, the decrease of ozone in the atmosphere, water and air pollution, soil erosion, and current levels of fish, forest and wildlife harvest are some of the subjects under consideration.

It is now generally accepted that better information, better analysis, and local participation in policy making and monitoring, can improve priority-settings and policy design (World Bank 1992). Farmers' perception of their environment as decision-makers is going to affect their behaviour in managing the farm. There is evidence that, under specific circumstances, local and rural people's knowledge has been successful in defining how to adapt and manage production systems to the environment (World Bank 1992).

2.2.3. Globalisation of Markets

The world is grouping in economic blocks and "common" markets. A globalisation of the markets has been established at a financial level. This implies that capital can flow around the world in search of the best opportunity. Thus, globalisation has also affected the markets at all levels; increasing formal arrangements between countries to form trade blocks have taken place (European Union [EU], North American Free Trade Agreement [NAFTA], Southern Cone Common Market [MERCOSUR]). According to Ruttan and von Witzke (1990), international open markets without policy distortions are a public good - advantageous to all parties.

In 1994, member countries of the General Agreement on Tariffs and Trade [GATT], created a new multilateral organisation, the World Trade Organisation [WTO], which will bring *all the separate agreements negotiated during the Uruguay Round under one roof* (World Bank 1995). According to this recent agreement, tariffs have been reduced to an average of 3.9 percent. This agreement implies a reduction in protective measures in the agricultural sector of developed countries. Consequently, a reduction in their domestic production is expected. This change is likely to produce new market opportunities for countries such as Uruguay. Domestic prices in developed countries have already fallen but international prices will probably increase. Farmers have been known to be generally responsive to increasing product prices. If an increase in prices is transferred to farmers, food production and exports from developing countries will increase, because profitability at farm level will also increase. Changes in the pattern of consumption have also taken place. Market opportunities for "natural" products appear to be expanding. Such changes in preferences are likely to have an impact on market sectors which may be exploited by some developing countries.

2.2.4. Globalisation of Knowledge

Information technologies are promoting changes at all levels, with the dramatic evolution of communication technologies, processing, storage and transmission of information at speed in a cheap and efficient way. Markets are becoming electronic, enabling people all over the world to apply their "know-how" to every aspect of productive and economic life (Tapscott 1995). This integration is producing enormous data flows and the problem decision-makers have is how to find useful information in order to make decisions.

> *"globalisation is changing the ways in which knowledge is produced, converted to technology and the technology transformed into goods and services* "(Howells and Wood 1993).

Nevertheless, how to use and integrate technologies for development in the agricultural sector represents a tremendous challenge. Well informed and integrated policy-makers, scientists, extensionists and farmers are going to be in a better position to achieve the goals of socio-economic and sustainable agricultural development.

2.2.5. Agricultural Community Challenge

New technologies are not neutral when they are transferred to the production and economic process (Hildebrand 1986; Astori 1979; Dent 1994). How to adapt, select and transfer these technologies to the agricultural process for the benefit of society at large represents a challenge. In the past, little attempt has been made to carry-out ex-ante analysis of the likely impacts of new technologies. The premise was that what science generated was good and should be transferred to farmers: an approach which has not always proved successful. It is necessary to think carefully about the likely impact which these new technologies may have on the agricultural sector. According to Cebreros (1991) the internalisation of these technologies is going to be quick and persuasive in the financial and services sectors, but not so fast in the industrial and mining sectors and will be complex and slow in the agricultural sector.

There are three important considerations to bear in mind in this analysis:

1. That the main forces that drive and produce these changes are external to the agricultural sector.

2. That these forces of change are going to continue with their own change-dynamic and are not directly affected by the agricultural process.

3. The increasing weakness of the agricultural sector in the development of macroeconomics policies.

Bearing these considerations in mind, the agricultural community must develop a strategy that will enable it to keep the possible benefits and avoid the perils that indiscriminate use of these technologies may cause in the rural community. Until now, however, the understanding of how to increase the productivity of complex agricultural systems (McCalla 1994) has been shallow and the effects on the socio-economic and ecological environment have not been defined clearly.

All these factors will affect a small country such as Uruguay. The main features of the country are presented in the following section.

2.3. General Features of Uruguay

This study will focus on the ELPS on the basaltic soils of Uruguay. A general outline of the country is presented, but orientated to the extensive grazing systems of the target regions.

2.3.1. Geography and Climate

Uruguay is one of the smallest South American countries, with an area of 176,215 square kilometres (68,037 square miles). It is located in the subtropical zone in the Western Hemisphere, between 30 and 35 degrees latitude South and 53 and 58 longitude. It is bordered by Brazil in the North and North East, has Argentina to the South and West and the Atlantic Ocean in the East.

The country consists mainly of rolling hills, with an average altitude of 117 meters (384 feet) and a highest point of 514 meters (1686 feet) above sea level. The main chain of hills runs along the Brazilian border to the South and East of the country. There are no economically significant supplies of mineral resources and agricultural land is the principal resource.

Uruguay is mostly covered by undulating grassy planes with tall, rich prairie grass and it is eminently suited for agriculture and cattle breeding. The good hydrography is based on the distribution of the ground network of rivers, sufficient to provide water for animal requirements almost all the year round. The entire territory of Uruguay is habitable.

Uruguay has a truly temperate climate with much sunshine. Daylight varies from around 10 hours in winter to 14 hours in summer and the average temperature varies between 11° C in winter and 27°C in summer. Maximum temperature can reach 40°C in the summer and the minimum - 4°C in winter.

Average annual precipitation varies between 1000 mm in the South and 1300 mm in the North. The climate is defined as humid mesothermic. There are no clear-cut boundaries between the rainy and the dry seasons and during 8 months of the year temperatures are above 10°C. On average, there are 30 days with frost per annum in the central zone of the country and 5 days on the Atlantic coast. Strong winds are common with hot North winds sometimes followed by chilly winds from the Argentine pampas, bringing in sudden drops in temperature.

The country is classified as Humid Subtropical and its vegetation is mainly gramineous. Predominant vegetation corresponds to the C4, summer grasses and, in less amount, to the C3, or winter grasses (Carámbula 1991). The irregular climatic conditions, the occasional drought and the low capacity of some soils to accumulate water contribute to the predominance of gramineous and herbaceous vegetation. Natural forests cover only 3% of the country.

2.3.2. Population

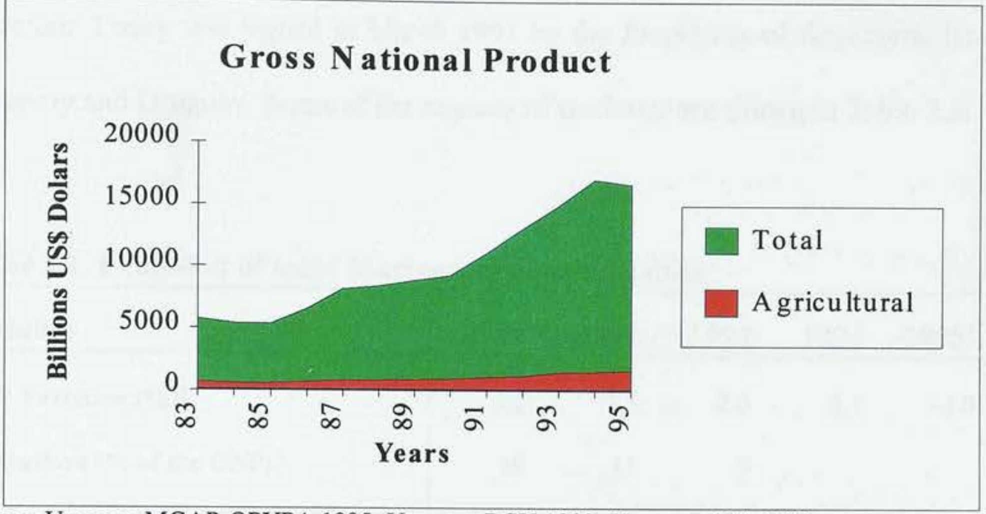
The estimated population is of 3,139,555 (Uruguay INE 1993), representing 17.8 inhabitants per square kilometre. According to The New Encyclopaedia Britannica (1995), its population is one of the most homogeneous and well integrated of Latin America. Most of the population is of Spanish or Italian descent. It is one of the most urbanised countries in the world, with more than 87.3 per cent of the population living in urban areas and only 12.7 percent living in rural areas. However, the economy depends mainly on agriculture and livestock farming. The literacy rate is 96 per cent. Life expectancy at birth is 70.88 years for males and 77.47 years for females.

The country is divided into 19 Departments (provinces). The capital, Montevideo, is home to 44.5 per cent of the total population of the country. The estimated population growth rate of the country is 0.74 percent and it is the lowest in Latin America. The low birth rate associated to a very low death rate means that 16 percent of the population is over 60 years old, 27 percent is under 15 and 57 percent is between 15 and 59.

2.3.3. General Economic features

Uruguay's economy is small with an important agricultural sector supplying a substantial percentage of the exports. The internal needs of the population were satisfied by the 1930s and all subsequent increases in production were destined for export. In the international market, the country can be defined as a "price taker". Until the 1950s the country enjoyed a relatively high standard of living from the exports of agroindustrial products. With the drop in the prices of commodities and agroindustrial products, the country started having economic problems. In order to reduce dependence on external trade and to increase the level of employment, policies using protective tariffs, import controls and preferential exchange rates were developed to stimulate the domestic industry. These problems increased in the 1970s with the rise in the price of oil, resulting in both the increase of inflation and of the external debt. The economy was stagnant for a long period of time. In 1984, investment away from the traditional agricultural sector was encouraged and the economy started to grow again (Figure 2.1.).

Figure 2.1. Evolution of Uruguay Gross National Product



Source: Uruguay MGAP-OPYPA 1995; Uruguay BCU 1992; Uruguay INE 1993

2.3.4. Recent Evolution of some Macro Economic Variables

The low increase in population (0.74 percent) and the already very high per-capita consumption of food (i.e. 67 kg/capita of beef consumption, 220 litres/capita of milk) suggests that all the increase in the production of the agricultural sector must be orientated to the international market. The new government has given top priority to the increase of production and exports as a long term objective to support economic growth. This is based on two short term goals: reduction of inflation and improvement of the country's competitiveness.

During recent years, Uruguay has also benefited from the general increase in world markets (an increase in the average world commodity prices in 1995 compared to the average of 1994) and from an increase in the demand for Uruguayan exports on the part of Argentina and Brazil (Antía 1995). The government has assigned top priority to the country's integration to the Common Market of the South, Mercosur. The Mercosur Treaty was signed in March 1991 by the Presidents of Argentina, Brazil, Paraguay and Uruguay. Some of the impacts of the latter are shown in Table 2.1.

Table 2.1. Evolution of some Macroeconomics Variables

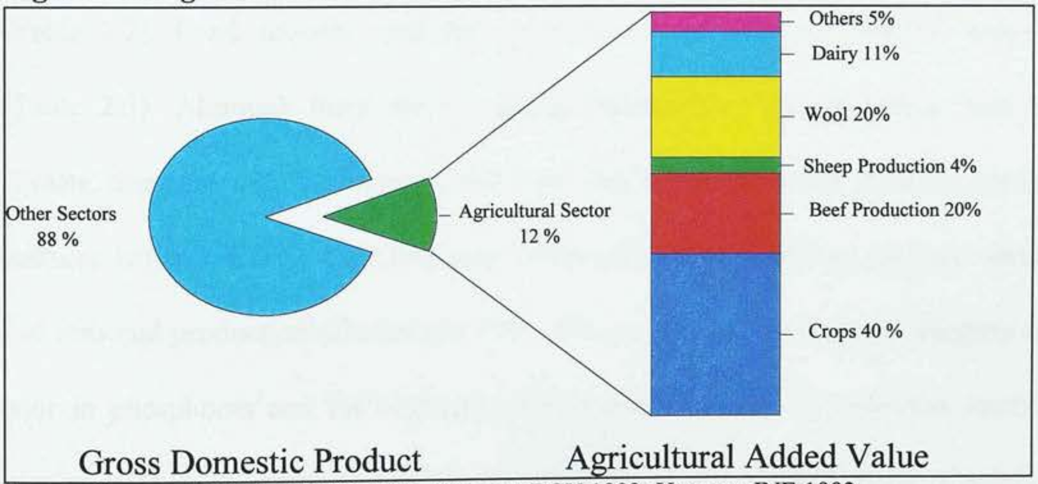
Variable	1991	1992	1993	1994	1995[1]
GNP Variation (%)[2]	3.2	7.9	2.5	5.1	-1.0
Agriculture (% of the GNP)[3]	10	11	9	..	..
Industry (% of the GNP)[3]	32	29	27	..	..
Services (% of the GNP)[3]	58	61	64	..	..
Agricultural GNP Variation (%)[2]	0.5	1.9	12.4	-5.1	6.5
Unemployment (%)[2]	8.9	9.0	8.4	9.2	10.8
Variation of Real Av. Wages (%)[2]	3.8	2.2	4.8	0.9	-3.0
Avg. annual rate of inflation (%)[4]	81.5	58.9	52.9	44.1	37.0
Exports of Goods (FOB, mill. US$)[2]	1604.7	1702.5	1645.3	1913.4	2160.0
Imports of Goods (CIF, mill US$)[2]	1636.5	2045.1	2325.7	2772.6	2856.0
GNP per Capita (US$)[5]	3226	3785	4272	4908	..
Population (millions)[6]	3.11	3.13	3.15	3.17	3.19
Human Devel. Index (IDH)Rank[7]	30	33	..	..	..

[1]Estimated by OPYPA (1995)
[2]OPYPA based on BCU and INE.
[3] World Development Report 1995.
[4] Average rate of inflation on consumer prices.
[5] Busqueda February 1996
[6] INE, Population Projections
[7] The Human Development Index [IDH] was elaborated by the United Nations Development Programme [UNDP] in order to have a more comprehensive indicator of the progress of a country. It is based on three basic components life expectancy, adult literacy rate and the purchasing-power-parity adjusted gross domestic domestic product per capita [PPP-adj-GDP per cap.] For each of the components a maximum and a minimum value is established and the output is an overall ranking for all the studied countries. As an example the highest value for 1992 is Canada with 0.932 and Uruguay is 33rd with 0.859.

2.3.5. Agricultural Sector

Historically, the Agricultural Sector has always been the "back-bone" of the Uruguayan economy, but it has been stagnant for almost 40 years. Technical change and productivity growth in this sector have been slow during the last decades (Figure 2.1). However, within the agricultural sector, some subsectors have shown notable increase in productivity: e.g. dairy, irrigated rice, citrus and selected horticultural crops (Ferreira and Da Cruz 1991; Echeverría, Ferreira and Dabezies 1991). Until 1992, grazing livestock (cattle and sheep) had not shown significant signs of change. The stagnant situation of the sector was strongly associated to the lack of change in the ELPS which contribute 44 percent of the agricultural added value (Figure 2.2). Between 1992 and 1995, the sector has grown and now shows some signs of dynamism.

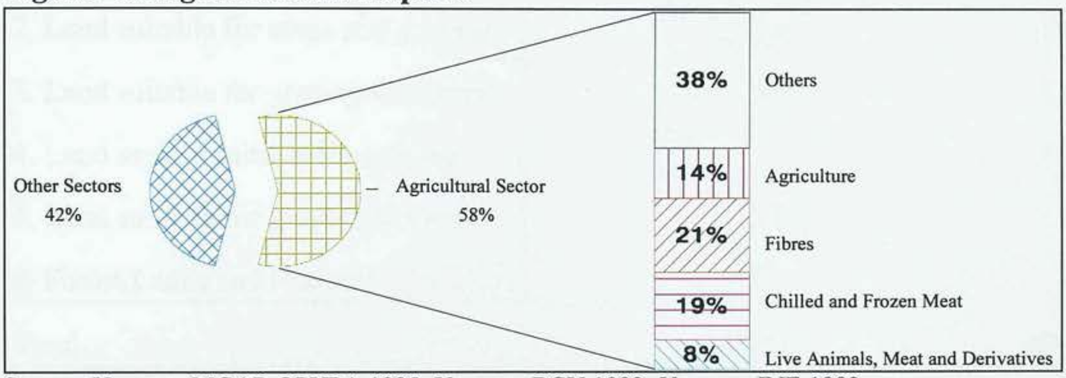
Figure 2.2. Agricultural Added Value



Source: Uruguay MGAP-OPYPA 1995; Uruguay BCU 1992; Uruguay INE 1993

The problem lies in the identification of the main reasons for low adoption of new technology and low productivity growth in ELPS. In spite of this situation, the agricultural sector accounted for more than 58 percent of total exports (Figure 2.3) in the period 19985-1995 (Uruguay MGAP-OPYPA 1995).

Figure 2.3. Agroindustrial Exports



Source: Uruguay MGAP-OPYPA 1995; Uruguay BCU 1992; Uruguay INE 1993

Soils Capacity.

Of the 17,100,685 hectares which are agricultural land (Uruguay MGAP-CONEAT 1994), nearly 62 % of it is mainly suitable for livestock production and forestry (Table 2.2). Land actually used for agriculture is of about 16,000,000 hectares (Table 2.3). Although there are no strong variations in the geography and the climate, there are wide variations in soil types that are associated to different sorts of pastures which differ in their botanical composition and, therefore, in their annual and seasonal production (Carámbula 1991; Olmos 1991). The soils of Uruguay are poor in phosphorus and the vegetation has a predominance of perennial summer species, with an average productivity of 3500 Kg of dry matter/ha/year (Cardelino

1988). Grasslands and improved pastures are used mainly for direct grazing of sheep, beef cattle and dairy cattle.

Table 2.2. Using Soils Capacity

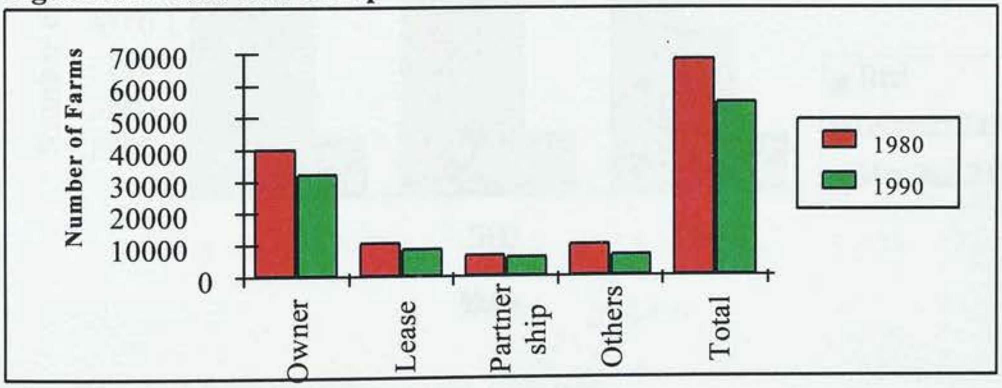
	Millions Hectares	Percentage
1. Land mainly suitable for crops	3.4	20
2. Land suitable for crops and grazing	3.1	18
3. Land suitable for grazing and crops	1.9	11
4. Land mainly suitable for grazing	7.1	41
5. Land suitable for grazing and rice	1.4	8
6. Forest Lands and National Parks	0.3	2
Total	17.2[8]	100

Source: Duran, A.based on Cayssials, R. and Alvarez, C. (1985)

Land ownership.

Most of the land is privately owned, but other arrangements like leasing and partnerships also occur (Figure 2.4).

Figure 2.4. Land Ownership



Source: Uruguay MGAP-DIEA Census 1990

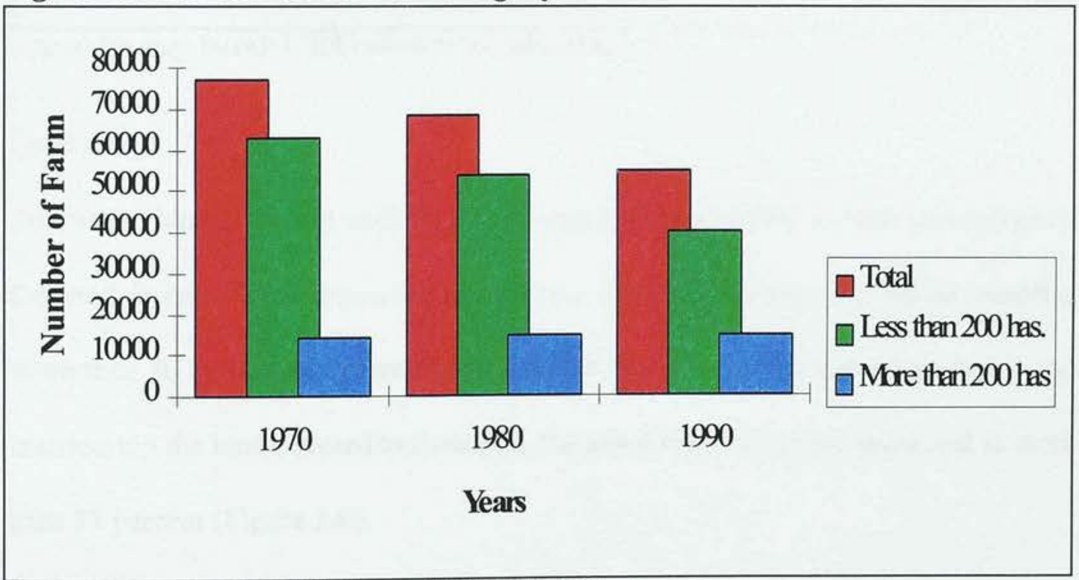
8Considering all the land estimated by the soils survey.

It is required by law that all farm boundaries must be delimited by a 7-steel wire fence. It is for this reason that there is a good fencing tradition.

Number of Farms.

Figure 2.5 represents the change in the number of farms from 1970 to 1990. Between the 1970 and the 1980 census, there was an 11 percent reduction in the number of farms, and a 20 percent between that of 1980 and 1990. This tendency is mainly explained by the decreasing number of small farms. This is the result of economic policies and the efforts of research extension institutions, who look for increased profitability. Competitiveness is eroding the survival capacity of rural communities at a high rate, in the same way as in other parts of the world (Harter and Hass cited by Corcoran and Dent 1994, Hildebrand 1986).

Figure 2.5. Number of Farms in Uruguay

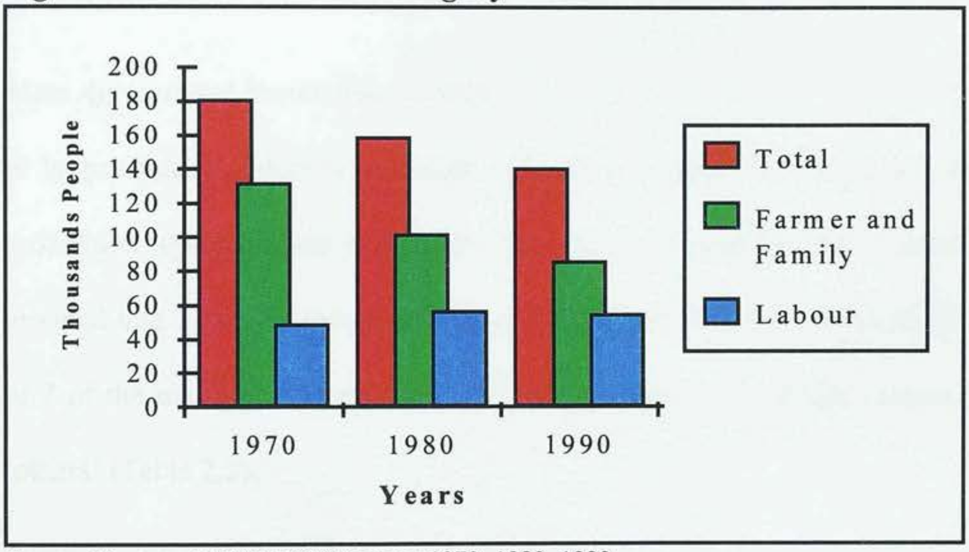


Source: Uruguay MGAP-DIEA Census 1970, 1980, 1990

Evolution of Rural Labour.

Figure 2.6 shows that the total number of workers is decreasing due mainly to a decrease in family farm labour (Figure 2.6). This is explained by the concentration of land in the hands of successful farmers and the decreasing number of small farms. Large farms need to hire labour in order to run the production system.

Figure 2.6. Rural Labour in Uruguay

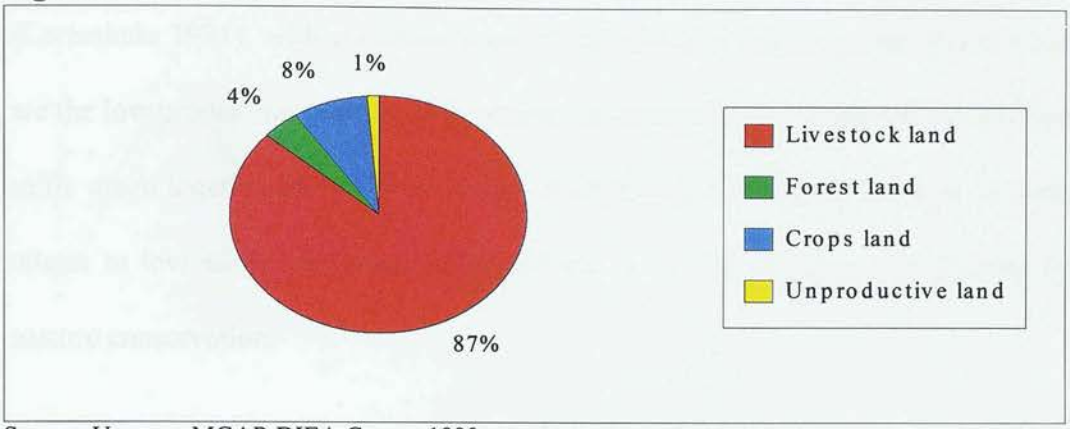


Source: Uruguay MGAP-DIEA Census 1970, 1980, 1990

Land usage.

Productive land is mainly dedicated to livestock systems. Only a small percentage of the land is considered unproductive (Figure 2.7). Considering the whole country, more than 80 percent of the total land devoted to agriculture is natural pastures, and considering the land devoted to livestock, the percentage of natural grassland is more than 87 percent (Figure 2.8).

Figure 2.7. Land use



Source: Uruguay MGAP-DIEA Census 1990

Main Agricultural Production Systems.

It is possible to identify different production systems in Uruguay. Based on production specialisation and scale, 126 different systems were identified and grouped into 11 major categories (Uruguay MGAP-DIEA 1990). The main features of 7 of the major groups are presented here whereas 4 are grouped under category 'others' (Table 2.3).

Extensive beef and sheep production systems.

This study is focused on the problems associated to ELPS. Mixed beef cattle and sheep grazing is the principal activity involving 52 percent of farmers and 74 percent of the land (Uruguay MGAP-DIEA 1994). The most important breeds for beef and wool are Hereford and Corriedale, respectively.

The area set aside for improved pastures is between 9 and 12 percent (Figure 2.8). Therefore, the pastoral systems are severely dependent on natural grasslands production. Natural pastures produce between 0.4 to 4 ton/ha/of Dry Matter [DM] (Carámbula 1991), with a marked seasonal distribution, where winter and summer are the low production seasons. The systems are pasture-based, where sheep and beef cattle graze together and animals remain outdoors all year round. A major problem relates to low winter and summer production, given the absence of a policies for pasture conservation.

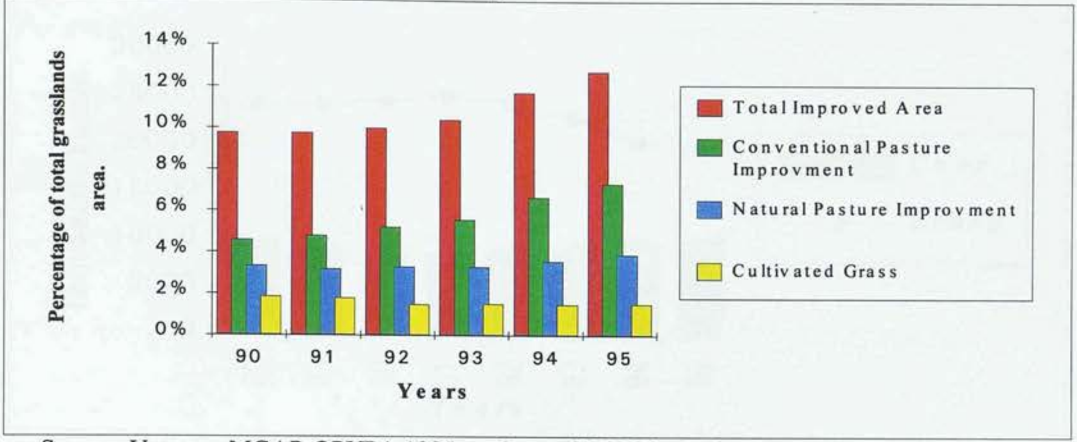
Table 2.3. Major Production Systems

Production Group	Farms	Farm workers	Total hectares	Cultivated hectares
1. Ext. beef and sheep systems	28,800	51,800	11,700,000	16,000
2. Extensive agriculture	5,400	12,300	1,800,000	334,000
3. Dairy	8,200	25,000	1,250,000	128,000
4. Irrigated rice	357	3,200	550,000	67,000
5. Citrus	280	2,000	58,000	18,000
6. Fruits	2,900	7,800	86,000	19,000
7. Horticulture	6,700	13,800	147,000	18,000
8. Others	2363	24,600	409,000	28,000
Total	55,000	140,500	16,000,000	610,000

Source: Uruguay MGAP-DIEA 1994, on base of 1990 census

During the last four years more incentives have been given for improving pasture production due to the expectation of better prices and lower fertiliser prices.

Figure 2.8. Evolution of Pastures Improvements

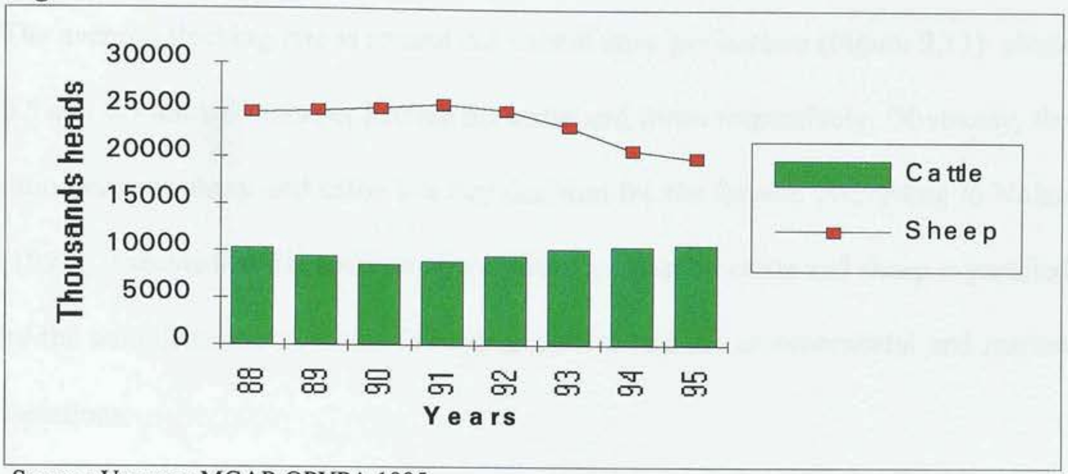


Source: Uruguay MGAP-OPYPA 1995, on base of DICOSE information

Beef production.

Uruguay's total beef stock as of 30 of June 1995 was 10.7 millions heads and an increase of 6.4 percent is predicted for June 1996 (Figure 2.9). Annual calving percentage varies between 75 and 64 percent. The first mating of heifers is at about 3 years of age, and 3 to 4 calves are produced in the productive life of the female. The extraction rate is just 16 percent and the average slaughter age for male beef animals is between 3.5 and 4.5 years at about 480 kg. Beef production is seasonal, with 70 to 80 percent being slaughtered between December and July, and 20 to 30 percent between August and November. The estimated annual meat production by hectare is about 52 kg. Meat production was seriously affected in 1989 by a devastating drought (Figure 2.10). Beef systems are classified as "finishers", "complete cycle" and "raisers". Finishers are orientated to buying thin animals and feeding them until they reach the slaughter live weight; complete cycle operators fatten almost all home produced animal and raisers mainly produce thin animals to sell to the finishers.

Figure 2.9. Stock Numbers

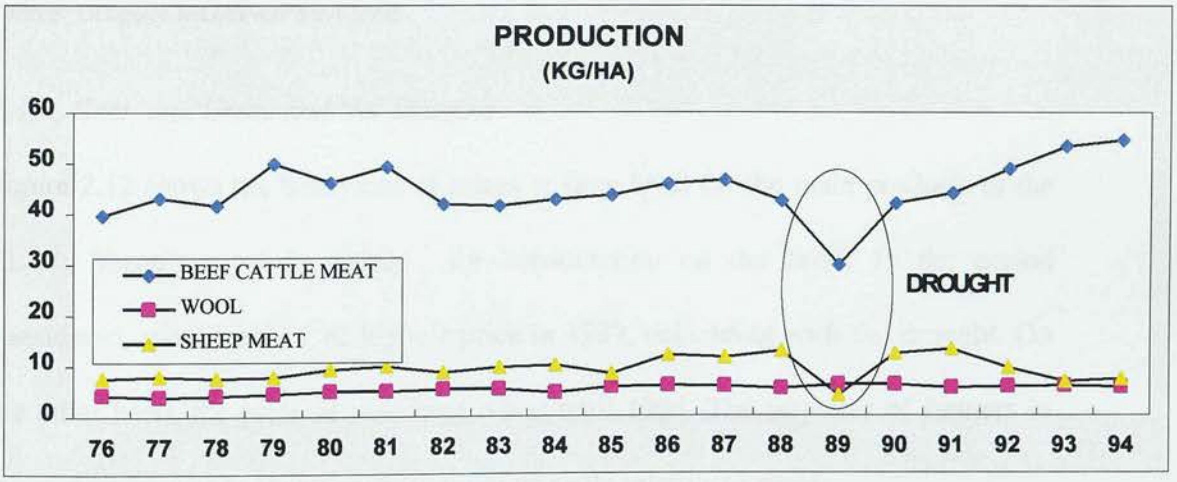


Source: Uruguay MGAP-OPYPA 1995

Sheep production.

About 75 percent of the sheep and wool production is based on Corriedale. The total number of sheep dropped from 20.8 millions as of 30 of June 1994 to 19.9 millions at 30 June 1995 (Figure 2.9). Lambs are slaughtered at 22-24 kg live weight. The lambing percentage is between 65 and 70 percent. Wool production per sheep is of about 3.5 to 4.0 kg (Figure 2.10).

Figure 2.10. Production

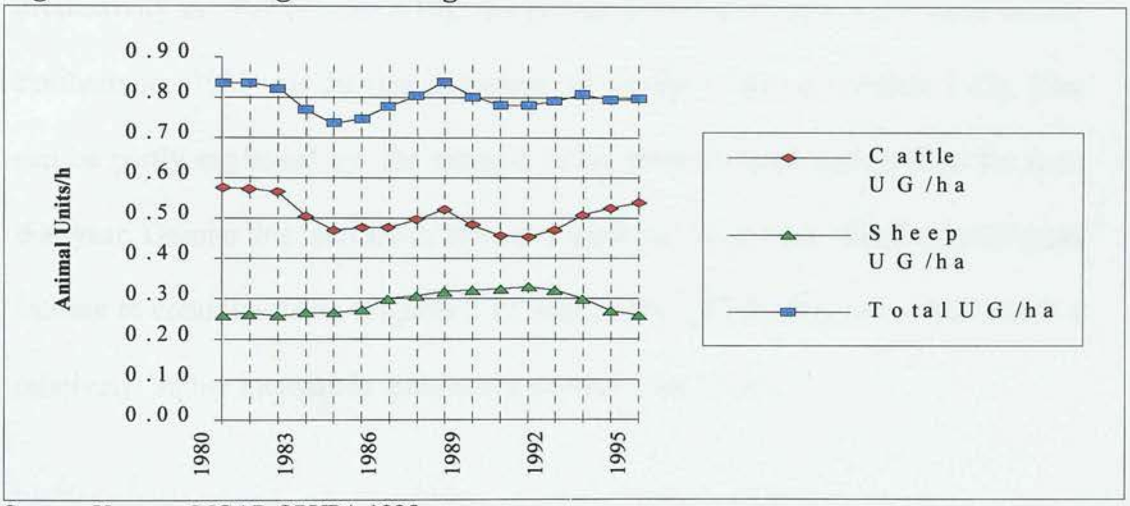


Source: Uruguay MGAP-OPYPA 1995

Stocking rate.

The average stocking rate is around 0.8 animal units per hectare (Figure 2.11): about 0.5 and 0.3 animal units per hectare for cattle and sheep respectively. Obviously, the ratio between sheep and cattle is a key decision for the farmer. According to Nolan (1992), it seems that the decision about mixed grazing by cattle and sheep is justified by the complementary grazing behaviour pattern and the environmental and market variations.

Figure 2.11. Stocking Rate Changes

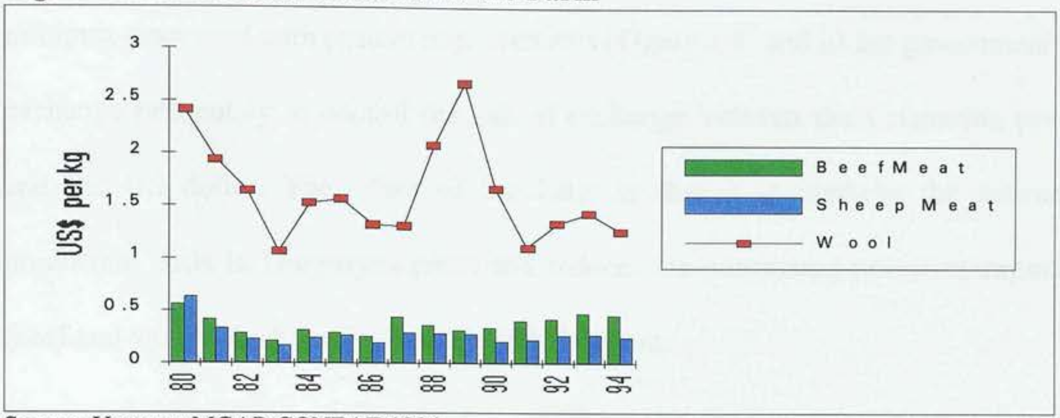


Source: Uruguay MGAP-OPYPA 1995

Price, Cost, and Gross and Net Margins.

Figure 2.12 shows the behaviour of prices at farm level for the main products of the ELPS. Sheep's meat is mainly for consumption on the farm. In the period considered, wool reached its highest price in 1989, coinciding with the drought. On the other hand, the price of beef kept rising until 1994. The response of farmers to these changes was to increase the number of cattle relative to sheep.

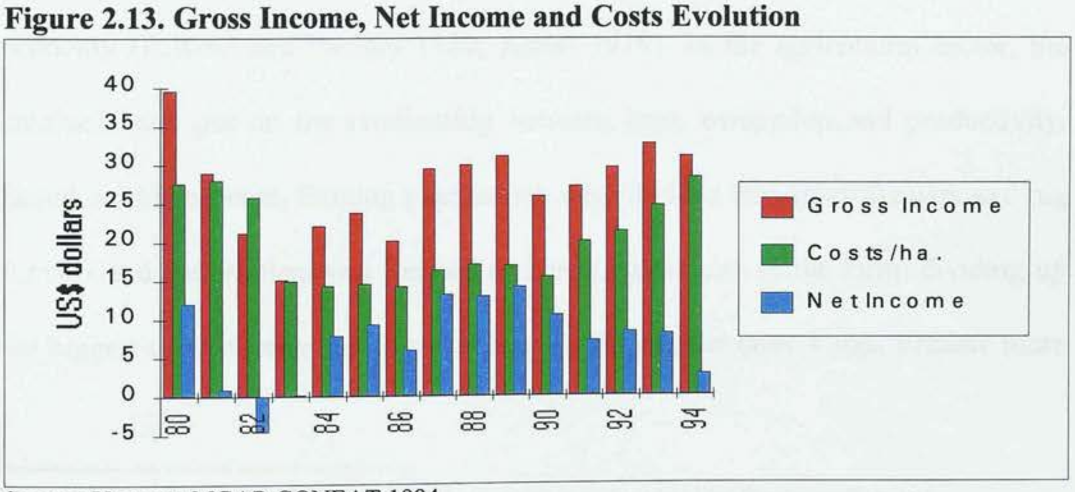
Figure 2.12. Evolution of Prices on the Farm



Source: Uruguay MGAP-CONEAT 1994

However strong the effect resulting from the drought was on production and productivity in 1989 (Figure 2.10), net income was not affected to the same extent. Furthermore, 1989 was the year of highest net income to farmers (Figure 2.13). That can be partly explained by the increase in the price of wool and beef on the farm that year. Despite this increase in price and productivity of beef -which caused gross income to continue rising (Figures 2.12 and 2.10)-, profitability decreased due to a relatively higher increase in production costs (Figure 2.13).

Figure 2.13. Gross Income, Net Income and Costs Evolution



Source: Uruguay MGAP-CONEAT 1994

This increase in the production cost could be explained by: i) the increase in the use of inputs associated with pasture improvements (Figure 2.8) and ii) the government's exchange rate policy to control the rate of exchange between the Uruguayan peso and the US dollar. The effect of the latter is that it strengthens the internal production costs in Uruguayan pesos and reduces the purchasing power of exports (beef and wool) which are paid mainly in US dollars.

2.4. Main explanations of the stagnant production of the ELPS

Following is a brief presentation intended to provide a better framework for the study's set-up, main ideas and actions regarding policies, research and extension level relevant to ELPS farmers in Uruguay between 1950 and 1995.

2.4.1. Economic Commission for Latin America (CEPAL) 1950-1959

CEPAL focused the economic problem of development on the structures[9] of the economy (Peixoto and Paolino 1980; Astori 1979). In the agricultural sector, the emphasis was put on the relationship between land, ownership and productivity. Based on this concept, farming populations were divided into small farmers and big farmers and the problem was focused on changing the size of the farm; dividing up the biggest unproductive farms and enlarging the smaller ones. Crops became more

[9] According to Peixoto and Paolino (1980) structure is conceived like the proportion and relationship that characterise an economy subsystem in space and time. The structural factors are those, that are more permanent while juncture factors represent those that change.

important than livestock for technology transfer. The livestock grazing system was the more competitive one available, and was used not only to support crop production, but also the industrial sector. The main economic advantage still lies in pastoral farming systems, and it is the most important economic activity.

At this stage, the non-existence of agricultural technology to support development was identified as a relevant problem. The search for and promotion of new technology for developing livestock production began in 1950 (Vassallo, Rubio and Methol 1987). Since there was lack of national research on ELPS' development and given the similarities between Uruguay and New Zealand, the idea was to import the successful technological packages used in New Zealand.

The model applied was known as "The New Zealand Model" [NM]. It consisted of importing seeds of different species (especially subterranean clover) used in New Zealand and Australia. Pasture-improvement recommendations to farmers suggested fertilising natural pastures or substituting natural pastures for improved pasture introduced by tillage. They also recommended the improvement of on-farm facilities for working with animals. The technique was a productive one, but by the end of the 1950s, evidence showed that the direct transfer of the New Zealand model had failed. The main argument was that farmers did not adopt the package because the varieties employed had not been adapted to Uruguay's conditions, and investment costs were high.

2.4.2. OPYPA-CIDE [10](1960-1973)

Following the general scientific and political trends of the 1960s, the Uruguayan Government developed policies to promote the modernisation of the agricultural sector. In 1959, the National Honorary Commission for Planning Agricultural Development [Plan] was created, its main objective being the promotion of technical changes in livestock production.

In 1963, CIDE was created in order to elaborate a Plan for National Economic and Social Development. The approach was based on changes in the economic structures and the reinforcement of Planning Institutions. Agricultural policies for the sector were developed mainly by the Ministry of Agriculture. The Plan was conceived as the most rational way to allocate the resources of the country.

The National Research Institutions and Public Extension Services were reinforced. Research, until that moment focused on cash crops, extended to pastures and animal production. The orientation of the research was biological and analytical. Therefore, with the technology generated by research institutions and farm subdivisions, the problem of increasing productivity for ELPS was mainly one of technology transfer and extension. With The World Bank's support, the public extension service was reinforced and transformed into an institution of extension and credit. The message

[10] OPYPA (Office of Agriculture Policy Program of the Livestock, Agriculture and Fisheries Ministry) CIDE (Commission for Investment and Economic Development)

relayed to farmers was mainly orientated towards increasing productivity. In spite of the technology and credit in the new package, was still not adopted by farmers. The interpretation of the decision to reject the new alternative package was as follows:

1. constraints on the physical and economic size of the farm in the case of small holders and tenants.

2. in the case of tenants, repayments of long and medium term investments required for the alternative package.

3. the income obtained using the traditional package was more than enough to support household consumption in the case of large farms. Also because management input for the "Traditional" package was low, and the farmer and his family could live in the city. This urban orientation led mostly to the investment of any surplus in the cites rather than to its reinvestment on the farms.

2.4.3. OPYPA, World Bank (1974-1977)

The interpretations of OPYPA and the World Bank are based on neo-classical[11] thinking. According to this interpretation, the main explanation for the rejection of

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[11]The neo-classical economic school was originated from the works of Marshall, Walras, Wicksell, Pareto and Fisher at the ends of the 19 century. It is called neo-classical because reappeared after the Second World war against the Keynesian school with works based on Walras, Pareto and Hicks.

new technology was the absence of economic stimuli at all farming levels. This conception argues that farmers are not just looking at the gross margin of a simple commodity, but that they are mainly making decisions based on the overall economic performance of the system. The extension agencies were forced to introduce the systems' concept according to similar reasoning. The rationale was that the farmer manages the farm in order to maximise income, looking mainly to the rate of return on investments on the whole farm (Uruguay MGAP-OPYPA 1973).

At research level, a criticism of the analytic approach was developed and the concept of Production Systems [PS] was introduced. Both at International and National levels the concept of Systems Research [SR] (Dent and Anderson 1974; Anderson 1974; Dillon 1975; Brockington 1974; Gastal 1975, 1980; Morley 1974; Wright 1974, 1979; Ferreira and Estradé 1980, 1983) started to emerge and was increasingly accepted as a valid approach to better understand agricultural production systems and to integrate the research products of analytical research. Nevertheless, at this stage in the development of production systems, the emphasis was put on the production system and here mainly on how the different production activities can be combined to maximise income.

2.4.4. SEPLACODI[12] / OPP[13] (1978-1991)

During this period all the support systems relating to the agricultural sector began to subside. The central policy office of the government (SEPLACODI and later OPP) is the agency responsible for developing policies for the agricultural sector, and the and the agricultural policy office (OPYPA) become advisory services to the central planning office of the Ministry of Agriculture.

Given the fact that the agricultural sector was still stagnant, the constraint to the adoption of new technology was identified in the input/output prices ratio. The rationale was that the competitive advantage of the country still lay in the ELPS, but given the intervention of the state through taxes, there existed a transfer of the resources from the agricultural sector to the industrial one. The relationship between effective and nominal protection (Balassa 1972, 1982) was studied in order to establish the competitive advantage of the different productions (Uruguay SEPLACODI 1978; Von Oven 1991, Macadar 1991). In 1991, Macadar concluded that all the ELPS were still competitive, but that the model which included the highest percentage of pasture improvements was the least competitive, because the higher production costs. However, in respect to foreign exchange for the country's economy, the model based on improved pastures is the best. But what becomes clear

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[12]Secretariat of Planning, Co-ordination and Diffusion.

[13] Office of Planning and Budget.

with this study is that farmers acting mainly on their rural people's knowledge and beliefs, arrive at the same sort of conclusions.

Even today the predominant idea is still neo-classical, and policy instruments are orientated towards providing technology under the assumption of neutrality in order to stimulate exports and competitiveness. Despite this, the links between research and extension are far from good.

2.5. Research and Extension

A brief description of the institutional evolution and communication between the research and extension complex and the farmers is presented.

2.5.1. Institutional Evolution

The research and extension services relevant to ELPS in Uruguay have been undertaken by different institutions. During the 1960s and until the 1980s the public Research and Extension services from the state were developed mainly for public institutions (CIAAB[14], CIVET[15] and PA[16]). The University contributed strongly towards research and extension until 1973, when institutional changes led to practically all funding going to education. The links between research and extension were not good and insufficient emphasis has been placed on social sciences.

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[14]Agricultural Research Centre "Alberto Boerger"
[15]Veterinary Research Centre
[16] Agricultural Plan.(Extension and Credit Agency)

This lack of understanding between the public research and extension institutions started with the reinforcement of the main institutions for Research and Extension in the 1960s, creating two separate institutions. Both were orientated mainly to provide biological, physical and economic outputs and no interest was shown for the farmer and the farming household as a decision-making unit. During the 1970s, private extension through cooperatives and farmers associations started growing. Nevertheless, the links between extension and research remained weak. The dominant orientation in the public institutions was the TOT until the 1980s. At a private level, the Regional Centres for Agricultural Experimentation [FUCREA], started to develop new ways of communicating between farmers and extensionists, based on a closer relationship. During the 1980s, research institutions had budgetary problems and the National Agricultural Research Institute [INIA] was created in 1989 with the purpose of setting up a new structure that could develop appropriate technologies in the country. In an attempt to give more participation to the farmers, the board of the institution was composed of four members, two delegates from the government and two delegates from farmers' organisations. Despite this, the relationship between the new Research Institution and the extension and the working environment can still be improved.

2.5.2. The lack of communication between farmers and urban oriented understanding

Table 2.4, presents a summary of the evolution of the main issues relating to the development of grazing systems in Uruguay. In all these interpretations, the solution comes from the point of view of the agricultural elite working in government institutions on research, agricultural policies and extension. The underlying assumption was that the principal problem with the production systems was a technical one, thus by offering a good technical package, the economy of the sector would grow. A dual approach was dominant in most of the theoretical studies. Small farmers versus big farmers; modern and developed production packages against backward and traditional systems; traditional farming systems against improved farming systems; entrepreneurial farmers against non-entrepreneurial farmers.

For more than 25 years the dominant ideology was based on neo-classical economics and analysis defining a farm as an enterprise focused on maximising income. The theory of the firm and the theory of rational choice was dominantly applied in order to analyse and evaluate agricultural firms. Again, the objective was developed by scientists and economists. A multitude of new management and econometric techniques were developed during the 1970s and early 1980 with the objective of helping politicians and farmers make better decisions.

Table 2.4. Evolution of Agricultural Thinking in Uruguay

Main Wave of Thinking	Economic Constraint for Agricultural Development	Agricultural Research	Extension and Transfer	Main Problems at Farm level	Main ideas to Support Farmers Decisions	Main Answer for non-adoption
CEPAL, 1950-1959 Economic-Structural-ism	Main constraints to the development are related to the Traditional Structure of the Economy. Land reform.	Analytic and oriented to cash crops. Very small budget assigned to research. Public Support.	Extension education. Oriented to show physical results. Mainly carried out for public Institutions with small financial support. Knowledge based on International scientific knowledge.	Land tenure and property rights. Large Farms vs. Small Farms	Encourage the investments on the farm in order to increase the number of fields, water and improved pastures.	Attributed to farmers' education, ignorance and credit- availability. There is not enough scientific knowledge to offer an adapted alternative technology.
OPYPA-CIDE 1960-1973 Develop-ment Economic Ideas.	The main constraints to development is the use of a "Traditional" model of production based on low inputs and low productivity.	Analytic but expanded to other commodities and disciplines. Financial reinforcement and restructuring of the main public research Institute The main target was to adopt the New-Zealand technical package.	Top-Down transfer and extension. Oriented to show physical results. Reinforce public financial support to Extension. Knowledge from international research and early results of National Research. The main objective was to spread the New Zealand technological way of production.	Farm tenure and property rights. Traditional ways of production Vs. Modern Way of Production	Increased Production and returns. Substitute a "Traditional" low-input and high labour way of production for a Modern high productivity and high input way of production.	**Land Tenure** **Small farmers**, capital and land constrains. **Tenants**, risk of tenure. **Large farmers,** enough income
OPYPA-WORLD BANK, 1974-1977 Neo-classical economic ideas	The main constraint is the returns of the Agricultural Systems related to other investment alternatives.	Analytic and Systemic Approach in order to generate technologies at the commercial scale. Decentralisation of the research experiments Scientific Knowledge had an alternative Improved Production System.	Top-Down Transfer and Extension. Knowledge based on the results of National Research Institutions At the policy level the emphasis was on Extension in order to transfer the new techniques. Oriented to show economic results. The development of private institutions of extension started to expand.	Returns and economic policies to provide economic stimulus to invest on the farms. Traditional Systems Vs. Improved Systems.	Show to the farmers the economic advantages of the new technology. Economic studies to support the work of the extension services and show better returns of the Improved System related to the Traditional System	Farmers that do not adopt the new techniques show "irrational" behaviour. Entrepreneurial Farmers have an economic rational behaviour and adopt the approach.

Table 2.4. Evolution of Agricultural Thinking in Uruguay (continued)

Main Wave of Thinking	Economic Constraint for Agricultural Development	Agricultural Research	Extension and Transfer	Main Problems at Farm level	Main ideas to Support Farmers Decisions	Main Answer for non-adoption
SEPLA-CODI 1978-1985 Neo-classical economic ideas	Main constraint is the State intervention in the economy. Free market is the best way to allocate resources.	Analytic and Systemic, physical-output oriented. Research need to be economically oriented. Very few on-farm research trials	Public Extension TOT oriented. Knowledge based on Research and Extension agencies experience. Increase on private extension farming systems oriented	Low returns of the new systems. Elimination of the main translation of resources to the industrial sector. Capitalist way of production Vs. Non-capitalist.	Economic oriented. Through different economic techniques, optimum economic resources allocation, shown. Also guidance about external markets.	Farmer's lack of knowledge for understanding basic economic principles. Low returns of the improved systems
OPP 1986-1991 Neo-classical economic ideas.	Public and Private Sector modernisation. Liberalisation of trade. Freedom of capital flows and foreign exchange transactions. Prioritise export commodities	Restructure of the main Agricultural Research Institution, into a public non-government right agent Farmers participate on the Board making decisions. Increase in the amount of funds for Support Research.	Decrease in funds for Public Extension. Farming systems oriented. Private extension increasing	Low returns of the new systems. Agricultural Research need to be oriented to satisfy needs of entrepreneurial farmers. Entrepreneurial farmers Vs.Familiy farmers.	Show farmers the advantages of the integration of the new production systems based on productivity and economic impact on the farm.	Few farmers with entrepreneurial abilities that can integrate the best technology to their conditions.
OPP 1991-1995 Neo-classic economic ideas.	Country-wide integration into a regional market of the South. MERCOSUR. Foot and Mouth disease-free permit search for higher value markets.	Prioritise research on export commodities and reinforce technology transfer.	Restructuring of the Public Extension. Farming system-oriented. Private extension continues increasing.	Low returns of the new systems. Agricultural Research need to be oriented to satisfy needs of entrepreneurial farmers. Entrepreneurial farmers Vs.Familiy farmers.	Show farmers the advantages of the integration of the new production systems based on productivity and economic impact on the farm.	Capacity of the system to provide inputs and capital goods

Source: (Peixoto and Paolino 1980; Astori 1979; Alonso and Arrarte 1980, Uruguay MGAP-OPYPA 1995)

Linear programming was used to establish comparisons between the traditional system used by the farmers and improved systems. The improved systems were developed through a combination of the activities offered by research institutions. The difference between the traditional and the improved systems was used to show the potential productivity of different groups of soils in the country: basaltic soils (Uruguay MGAP-DIEA 1974); sandy soils (Uruguay MGAP-DIEA 1975); sub-zone Garzon soils (Uruguay MGAP-DIEA 1975); crystalline soils (Uruguay MGAP-DIEA 1975); cretasic soils (Uruguay MGAP -DIEA 1975); agricultural soils (Uruguay MGAP-DIEA 1977). Also output solutions using games theory and risk (Félix and Vila 1979), simulation models (Ferreira and Estradé 1980), linear programming and risk (Acosta y Lara 1979; Aicardi and Pérez 1979) and farm records analysis (Estradé, Ferreira and Zaffaroni 1977) were developed. The method for transferring technology to farmers was merely a meeting with farmers to show them the output of the programme in order to discuss the solutions obtained through the use of different methods. The solution, in many cases, came attached together with a sensitivity analysis using variations in the price of the products and its cost. The evidence shows that this approach was narrow and ineffective.

The communication and the dominant neo-classical concepts were the problem, with "irrational" farmers not making decisions based on a "rational" way of thinking. Further studies take into account a more broad concept and argue that a farmer makes a decision in order to satisfy utility (Lin, Dean and Moore 1974; Anderson, Dillon and Hardaker 1977). According to these normative studies, the way in which a farmer makes decisions is ruled by his own concepts of utility. This concept may integrate multiple objectives that he may try to "trade off", such as income, security, lifestyle, social status, and family needs (Romero and Rehman 1989).

Alternatively, the emphasis on household and family relationships was limited to studies focused on peasants or small farmers systems (Astori *et al.* 1982), because a bias imagined that all larger farmers are entrepreneurial. In all these cases until now, the superiority of "rational science" was assumed, and farmers' experience and knowledge was not taken into account, and the top-down transfer of technology approach was dominant. The information presented show that the policies and strategies that have been followed until now are not successful and lack of understanding between farmers, extensionists and scientists still exists.

2.6. Summary of Considerations

This Chapter has presented a description of the main global changes affecting the world's economy such as the globalisation of knowledge, the environment, and the markets (Section 2.2). It also described these changes as representing a challenge to the agricultural community worldwide.which will particularly affect a small economy such as the Uruguayan.

The new economic policies of world trade liberalisation, open markets and regional integration that have been adopted for the agricultural sector promote changes at farm level. New economic policies represent new challenges, new rules of the game, which mean that new information needed by farmers to be successful on their farms must be generated (Section 2.2).

Almost all conditions necessary for a relatively efficient low input, high output of good quality meat and wool production from grasslands, are found in Uruguay (Section 2.3). The increasing interest in the world for natural products based on low input of chemicals and hormones puts Uruguay in a privileged position in terms of potential high forage production resources offered by the climate and the present clean state of resources (Nolan 1992). The challenge to the Uruguayan agricultural community then, is how to develop an alternative system for increased meat and wool production whilst avoiding the perils and mistakes found in the intensive production systems used in Europe and the United States. Among scientists, extensionists and farmers there exists the belief that management alone can be used to improve the pastures, animal production and efficiency of the production systems (Olmos 1990, 1991, 1992; Berruti *et al.* 1993; Berretta 1989, 1994; Bemhaja 1993; Berretta and Bemhaja 1994; Formoso 1994; Pittaluga and Cásas 1974).

As described in Section 2.4, Uruguay's economic policy has been orientated towards the increase of economic profit and little attention has been paid to the socio-economic aspects. For more than 25 years the agricultural policy has mainly been based on neo-classical and normative economic approaches. Therefore, (Section 2.4 and Table 2.4) Uruguayan agricultural policy has been mainly orientated to the average farmer, seldom considering the different characteristics of farmers' population. The dominant TOT dual approach has oversimplified the farm families diversity and does not consider the livestock farm as a human activity system, in an explicit way (Sørensen and Kristensen 1992).

Research and extension services were mainly orientated towards generating and offering biological, physical and economical outputs, but no emphasis has been placed on understanding the farm as a family system (Section 2.5).

A new approach focused on determining what people, rules, knowledge and information sources are used by the different "types" of farmers to make real management and economic decisions, is necessary in order to improve the lack of communication between farmers and urban orientated decision makers. The identification of these rules and information flows can later be used to define possible areas where computer modelling and other tools could be used to provide assistance in the decision-making process. To identify the main factors and inner mechanisms that explain the dynamics of the different "type" of decision-making farmers, would be crucial to support policy-makers at all levels in order to develop policies that can better target the agricultural research and extension complex into recommendation domains (Perrin *et al.* 1976; Collinson 1982; Williams 1994) more appropriate to meet the real needs of farmers.

Chapter 3

Understanding decision-making at farm level

3.1. Introduction

This Chapter provides a conceptual framework for the study of the decision making process at farm level. As presented in Chapter 2, agricultural policies have often been formulated based on an "aggregate" or average farmer whose main motivation is assumed to be to drive his production systems towards economic goals (Skerrat 1995). Agricultural researchers worked on the assumption that technology is neutral to farmers adoption (Hildebrand 1986; David 1992). Given the failures in agricultural policies, attention was directed to improve the efficiency of such policies. Here, better understanding of the logic and behaviour of the **people** involved in farming system is needed.

Two main levels in the analysis of the decision making process are often described in the literature (Jones 1977). The first one is mainly related to the strategy and general guidelines and orientation of farm planning or the decision-making policy. The focus is on decisions that involve resources in the medium and long terms. The second level is directed towards a better understanding of individual or day-to-day decisions, mainly in connection with the organisational aspects of the farm (Robison 1988).

Decision-making at farm level is the last filter through which development policies have to pass through in order to have any impact (Singh and Ahn 1978). Therefore, it is crucial to have a sound understanding of this process.

Within these two main levels of analysis, economists and managers' focus is more on how decisions ought to be made whilst the work of behaviourists can be divided into that of cognitive psychologists, who focus on understanding short term decisions related to monitoring or control, and that of other approaches that focus on decision making as an aspect of behaviour. Most of these studies are static and focused solely on the decision maker, ignoring the influence of other people and the family.

A systemic and evolutionary understanding of the decision-making process involving the dynamics of the process and the influence of associated influences (people) is presented here as a valid alternative. One of the main objectives of this study is to find empirical evidence in order to understand better the decision-making processes and to explore other ways to support farmers in the achievement of their goals.

3.2. Basic ideas about decision-making

Interest in the theory of decision has been growing within different disciplines. At first, decision-making theory was more focused on the work of economists, anthropologists, mathematicians, psychologists and philosophers (Eisgruber and Nielson 1963). Other fields of work and disciplines such as extension science, engineering, information science, agronomy, computer science are now looking for a better understanding of the decision-making process.

Nowadays, research and modelling is carried out in decisional behaviour, soft systems, knowledge base systems, information systems, decision support systems, and decision support systems integrated with expert systems (Jacobsen 1994; Zachariasse 1996). This growth during recent years is explained mainly by the new possibilities brought forth by elaborate tools for decision support, based on the development of Information Technologies [IT], (Electronic, Communication and Computer Science) that can be used to improve the effectiveness and efficiency of decision-making in different fields of work (McCosh and Morton 1978; Alter 1980; Mclean and Sol 1986; Heymann and Bloom 1988). In spite of this, until now, each discipline has followed its own perception of the problem.

A more systemic and holistic understanding of the decision-making process is necessary. Decision-making is a complex process and better understanding of this process lies beyond disciplinary boundaries. An integrated approach based on system theory would seem appropriate.

> *"Now, more than ever, decision makers at all levels, need an increasing amount of information to help them understand the possible outcomes of their decisions and develop plans and policies for achieving their goals"*(Jones 1991).

New possibilities offered by IT and the fact that the tools and methods used over recent years have not given enough consideration to the decision-making process at farm level, have awakened interest in decision-making among the agricultural community (e.g. Dent 1994; Attonaty and Soler 1994; Röling 1994). In order to orient next developments for decision support systems towards a more integrated approach, a comprehensive understanding about the inner elements of the process is necessary. This research attempts to provide some empirical evidence for the development of some behavioural descriptive models which can help conceptualise how to integrate the "natural" human decision support systems usually used by farmers with hard (quantitative) decision support systems frequently described in research literature.

3.3. Main approaches and models for the study of decision-making

Decision-making studies may be conveniently grouped into those based on normative economics and those based on behavioural and psychological approaches (Douglas 1986; Smidts 1990; Dent 1994; Weber 1994; Jacobsen 1994; Bockelmann and Lentz 1994).

3.3.1. Normative perspective

Normative economics involve the study of which economic agents ought to do (Ruffin and Gregory 1990). According to Cancian (1980), the normative perspective is interested in what decision people should choose subject to a set of constraints and goals. This approach is based on the assumption that individuals act towards maximising one or more objectives.

• The **rational perspective** is based on neo-classic microeconomics (Doll and Orazem 1984). Rationality is one of the major foundations of classical decision theory's support (Jacobsen 1990). The meaning and implications of being rational, is a topic widely treated in the literature (Simon 1955; 1957; Diesing 1962; Steinbruner 1974; Sage 1981). This perspective is encapsulated in the following quotation:

> *"define decision-making as the process an "economic man" follows in selecting courses of action out of determined usable alternatives "* (Douglas 1986).

The concept of "economic man" is founded on the assumption of rational choice on the part of people within the economic system. The model proposed is an "economic man" who chooses from different alternatives, based purely on rational and objective cost-benefit analysis, having through perfect information and knowledge in order to maximise his goals (Lewis 1991). A choice is considered rational if it is in agreement with the decision maker's objectives (Douglas 1986). This perspective normally includes the non realistic assumption that the only objective for people is to maximise financial gain in a working environment which provides full information, with certainty. That is to say, that people's behaviour, as individual decision makers, may be said to be rational and self-interested if it responds to economic alternatives.

• The **theory of utility,** is also mainly developed by economists and based on von Neumann and Morgenstern's work (1947) who developed a concept in order to explain which principles people should apply in order to evaluate alternatives about which they are uncertain. Their focus was on describing risky decision-making (Fleisher and Robison 1985; Smidts 1990). According to Watson and Buede (1987) it has probably been the most influential contribution to the development of modern risk decision analysis. They come-up with a normative decision rule called the **expected utility** rule. This utility rule defines how a decision maker ought to choose amongst a set of risky alternatives (Smidts 1990). This model is also based on the neo-classical theory of the firm, which defines profit maximising behaviour as "limited by other factors" (Douglas 1986) such as people's behaviour to economy and market features (Schluter and Mount 1976; Kingma and Kerridge 1977; Singh and Ahn 1978; Desai 1979). In spite of this, there has been evidence of failure in the theory of expected utility in describing how people choose when choosing from risky or uncertain alternatives (Shoemaker 1982; Lopes 1990; cited by Weber 1994).

3.3.2. Behavioural perspective

This perspective is focused on identifying the main rules which govern people in order to behaviour and decision-making. This perspective presumes that individuals are more interested in satisfying[1] their objectives rather than attempting to realise some maxima. The approach is mainly related to the work of psychologists

[1] Accepted as adequate by the individual.

and sociologists, with special emphasis in the development of descriptive models decision- makers go by when deciding (Dent 1994 b; Weber 1994). Cognitive psychologists have developed models focused on the study of individual decision-making. These interpretations are based on the explanation of "natural decision models" (Tversky 1972; Gladwin and Murtaugh 1980; Gladwin 1980). They are focused on how people, on the basis of heuristic and simplified rules, arrive at decisions in complex situations. Attempts have been made to describe decision-making procedures without complete information (Smidts 1990).

Those proposing these approaches, argue that people have multiple objectives and that the decision process is not exclusively driven towards simple criteria such as maximising economic profit. Criticism of economic theories, comes from the fact that they do not take into account the simplifying procedures or heuristics that people use in real life to render their decision-making easier (Quinn 1978 cited by Gladwin 1980). In fact, people seem to use simple "rules of thumb" to support their daily decisions (Cyert and March 1963; Hall and Hitch 1951 cited by Gladwin 1980). There is a number of alternative models in this context, but the dominant work was proposed by Simon (1955; 1957; 1983). Lewis (1991), found that 84 percent of the introductory texts include Simon's phases of decision-making and 53 percent present his model as the unique conceptual base for the understanding of decision-making. Simon (1955, 1957) developed a model of "satisficing" behaviour where the decision maker acts according to bounded rational behaviour, attempting to achieve an acceptable solution given a set of possibilities open to him. Here, the goals are considered as constraints which define the boundaries of the decision-making process and within which lie the set of acceptable solutions. According to Checkland (1978), Simon's work is one of the main contributions to the hard systems paradigm. Lewis (1991), points out that the main weakness in Simon's work is:

> " *...that whilst it provides an approach to decision making well suited to the operation of a machine it does not do justice to subtleties of the way in which human beings make sense of their world and approach decision making.* "

Conflicting objectives, authority and power are ignored. Lewis also added that:

> "*no description of the decision making process would be complete or make any sense without consideration of social and political factors which surrounded decision makers*".

The above approaches are mainly centred on the appreciation of the decision-making process at the moment when decisions are made (Brunåker 1990) and under the assumption that the decision maker is an individual.

3.3.3. Techniques and "models" for decision support

Both of these schools have kept on growing over a long period of time, while ignoring or criticising each other, but both of them agree to the need for developing models and descriptive decision research in order to understand the process (Bokelmann and Lentz 1994).

Within these two currents, it is possible to identify a set of techniques and procedures designed to give support to individuals and organisations in decision-making. The need to develop tools is based mainly on the fact that the situation which the decision maker generally faced with involves multiple objectives (Gasson 1973; Fergusson 1984; Romero and Rehman 1989; Fairweather and Keating 1990, 1994; Gasson and Errington 1993, Errington and Gasson 1994) and incomplete information (Nelson and Winter 1976; Humphreys and Berkeley 1983; Linstone 1989; Andersen 1994). Some techniques are focused on how to improve decision-making by careful analysis of past decisions: the decision analysis approach (Smidts 1990). The former produced the theoretical base for the development of early decision support systems which concentrated on large firms and on business management control (McCosh and Scott Morton 1978). Mainly, these tools are oriented towards the processing of information in order to improve the decision maker's analytic power.

This area, impelled mainly by information and communication technologies, requires better understanding of the dynamics of the decision-making process in order to develop products that can be really useful. However, most of this information tools were based on Simon's model of behaviour, and did not consider the influence of socio-economic factors.

In the agricultural sector, initially, the models developed were based mainly on the analysis of structural and economic variables, and considered that an individual decision maker acted as an "economic man". Their application, based on linear programming or simulation, was used to identify "optimal" solutions that were only used by a very small number of farmers and to solve some specific problems[2]. These models (essentially normative in nature) ignore the socio-economic elements of the systems such as the family and the interrelationship with the working environment.

The development of effective tools to support decision makers requires, first of all, of the better understanding of human problem-solving routines and decision-making processes and then of a study on how to transform this understanding into tools.

3.3.4. The evolutionary approach

Other approaches concentrate on the analysis of technical change and innovation based on an evolutionary perspective. The idea is to establish a parallel concept to that of Darwin's evolutionary theory (Nelson and Winter 1973, 1974, 1982). In the same way in which biological species are submitted to the selection process by the environment inducing-changes in genetic information through mutation, firms may be considered as being submitted to changes in the competitive economic environment, and this generating a selection process (Andersen 1994).

[2] For example, in other countries such as the UK and USA, LP was used by farmers to obtain solutions for minimising the cost of the ration for animal feeding.

Possas (1989) identified two main currents of thinking: the first one at Yale University, based on Nelson and Winter[3] work's and the other one at the University of Sussex[4]. These are non-neo-classical approaches which started with Schumpeter's (1934 cited by Andersen 1994) ideas about competition, technical change and innovation and for this reason, are also known as the Neo-Schumpeterian approaches (Possas 1989; Nelson and Winter 1973; Andersen 1994). They are focused on providing an explanation for the processes of generation and diffusion of new technologies based on the study of competitiveness in unbalanced and uncertain situations. These approaches criticise the static model used in neo-classical economics in explaining decisions that involve technical change. Technical change involves the dynamic process of evolution, and therefore, a static model cannot provide useful analysis. Economics and environment (in the broadest sense) are both complex systems that evolve in continuous or discontinuous processes interacting between themselves. These two systems are linked mainly by the decision-making process performed by society such as control environmental forces in order to achieve their objectives. Neo-schumpeterian approaches do not focus on how passive, static and balanced systems vary when some external change is introduced (such as market variations), but rather study an evolving and self transforming system (Andersen 1994).

According to the evolutionary approach, economic rationale is focused on cautious and defensive behaviour that is expressed through the employment of common

[3]This current has an explicit analogy with the biological process of evolution.
[4]This is more focused on the macrodynamic impact on innovations inspired by Schumpeterian ideas.

routines and procedures successfully used in the past to face up to similar ill-defined problems in uncertainty and not having thorough perfect information. Uncertainty is the principal determinant of individual behaviour in decision situations. People prefer to avoid risks and reduce uncertainty by following well proved routines (Berkeley and Humphreys 1982; Humphreys and Berkeley 1983). Under an evolutionary understanding, people may be seen as searching for information to reduce uncertainty. The use of feed-back mechanisms of learning by iterative trial-and-error constitute ways to reduce uncertainty that are an inherent characteristic of complex decision situations (Humphreys and Berkeley 1983).

Therefore, it appears that decision-making in uncertainty is based on heuristics and "rules of thumb" developed through the interaction with the working environment. These routine procedures are used to solve short, medium and long term decisions (Possas 1989).

Decision-making at farm level is performed within an evolving set of circumstances where the objectives driving the system are multiple, vaguely defined and sometimes conflictive. This alternative conception implies that changes in the systems are not only promoted by the influence of external factors but that they take place in an evolutionary process: they are the product of the interrelationships between the forces of change in the environment and the forces of changes in the system under study (Reggiani and Nijkamp 1994). Therefore it appears that the evolutionary approach may provide a better basis for the understanding of the dynamics of the process of decision-making.

3.4. The Farm Decision Making Unit

The objective of this study, is to develop a better understanding of the process of decision-making at farm level. There is strong evidence that the **farm family** plays central role in this process (Singh and Ahn 1978; Astori *et al*. 1982; Douglas 1986; Gasson and Errington 1993; Errington and Gasson 1994; Willock *et al*. 1994; Gafsi and Brossier 1996).

The decision making process at farm level can be better understood if the whole range of people involved in the process are considered within an evolving social, cultural and institutional framework. Consequently, decision making actions need to be considered within the whole farm family system, whose fuzzy limits are adjusted over time, and whose objectives are dynamic, complex and conflicting in character. The evolution of the farm decision-making unit [FD-MU][5] is the result of it is interaction with the working environment. The composition of the FD-MU will change over time and will also change for different type of decisions. For certain situations, people who are outside the family may be incorporated to the FD-MU (such as the farm manager and the farm foreman). **Therefore, it can be hypothesised that the FD-MU is comprised of the farmer (as the decision**

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[5] Borrowed from Dent (1994)

maker), some members of the immediate family and some elements of "trusted people". The concept of farm decision making unit [FD-MU] as the unit which allocates resources appears to be a more suitable concept than that of a solo farmer (Gasson and Errington 1993; Errington and Gasson 1994; Dent 1994; Skerrat 1995) for the better understanding of decision making at farm level.

3.4.1. The family

Until now, the main approach has been that of considering the farmer as the unique actor in the decision-making process (Sonka and Patrick 1984; Fleisher and Robison 1985). Not very much attention has been paid to the interrelationship between the farmer and the family. Every method and technique (Mapp and Helmers 1984) has been oriented towards the farmer as the only decision maker on how to maximise income or utility. The importance of the family in farm decision-making is now being recognised (Brossier and Chia 1986; Errington and Tranter 1991; Gasson and Errington 1993; Errington and Gasson 1994; Dent 1994; Corcoran and Dent 1994; Bryden 1994). Bollman, Whitener and Tung (1995), determine that despite the increasing modernisation of farming, most of the farms are still owned and operated by families. Less than 2 percent of the farms in Canada in 1991 and in the United States in 1987 were organised as non-family corporations.

3.4.2. The decision maker

The decision maker is usually the farmer, who behaves as the kernel in the decision making unit. How each farmer reacts and decides at a moment in time is strongly affected by long standing knowledge, past experiences, ethical and cultural values, the intensity and duration of the last stimuli received and by their relationship with the family and the "trusted people". This implies that decision-making is part of an evolutionary process where the behaviour, the knowledge and the experience of decisions made in the past are supporting links in future decisions and behaviour.

> *"The personal value systems of individuals influence the decision-making process and its outcome by affecting the perception of situations, problems, individual and organisational success, the choice process, interpersonal relations involved in decision-making, limits of ethical behaviour, and acceptance of organisational goals"*(Gordon 1993).

In the process of decision-making, motivation would therefore be associated to past experience, to the information received and to the perception of the problem. That is to say that the decision maker has his own past experience and that he is permanently updated by a feed-back process with the results of his new actions affecting his perception of himself and that of the working environment. It is a combination of this information and the decision maker's own view of the future which instigates the action.

Human capacity to comprehend, prepare and elucidate complex questions is small in relation to the dimension of real problems whose solving is relevant for an objective, and rational behaviour in the real world and for conscious approach to such objective rationality (Simon 1957; Watson and Buede 1987). Therefore, the information and the knowledge necessary to make decisions needs to be encapsulated into clear routines and "rules of thumb".

> *"What a farmer distinguishes is ruled in part by his past experience and thus by what he recalls. What he recalls is, in part, controlled by the stimuli which he receives"* (Morris 1969).

The important thing is that there are individual characteristics such as age, education, knowledge, personality, social status, past experience, lifestyle, cultural and ethical values which are associated to each person when acting as a decision maker.

3.4.3. The "trusted people"

Despite the central role of the decision maker (farmer) in the decision making process, there is some evidence that decision making is undertaken by individuals working in social groups (Mitchell 1978; Röling 1994). As Skerratt (1995) pointed out that it is not possible to understand the decision making process at farm level if the farmer is considered as an individual separated from the social context which affects his behaviour. The fact that decision making is a social process, adds complexity to the process. Gasson (1971) writes about the importance of "significant others" and she points out that:

> " *An individual is thought to compare his own situation with his subjective assessment of the situation of others who are significant to him, and thus he experiences satisfaction or frustration, not in relation to an absolute criterion or his own alternative position but relative to others"...*

She suggests that not only could the family be relevant to the study of decision-making at farm level, but also other significant people surrounding the family. The latter could be the extended family, other farmers, friends, advisers, relatives or employees. If the farmer is considered as a social actor, the interrelationship between the farmer, the family and the significant others is an important issue to be analysed. According to Kennedy (1977), land-lords, land agents, clergymen and some professionals such as school teachers and rural doctors frequently played a crucial leading role in the formation of societies. It appears that such prominent local personalities often acted as secondary sources of information, reassurance and initiative. Fearne (1989) pointed out the importance of neighbouring farmers playing this role.

In most cases the decision maker has been brought up in a farming family (Errington, Giles and Oakley 1988; Errington and Tranter 1991) and, therefore, there is a strong relationship between the farmer, the family and the surrounding friendship network. The FD-MU is a dynamic entity, that has established relationships with the surrounding environment which go beyond the individual relationship. Errington (1985) has noted that the "emotional" component is very important. Farmers receive advice and share decisions with people they trust and these are the "trusted people". Sharing the responsibility of making decisions, the decision maker seeks to confide in people that he really trusts and also in people who are emotionally attached to him. This implies that his decisions will not be evaluated just through his own criteria. Rather, all the surrounding "trusted people" will make their opinion regarding the decision taken known. The decision-maker will not always look to satisfy his own needs or perceptions only, but will try to satisfy the objectives of those who comprise the FD-MU or are close to him.

The FD-MU is responsible for choosing from several courses of action (Johnson 1957; cited by Groenewald 1987). Associated to the concept of responsibility is the concept of delegating in decision-making (Errington 1985, 1986). Errington (1984) looks at delegating as a managerial tool in order to enable the farmer to make the best use of his time and information. An important point of delegating in decision-making, is that it creates the opportunity of training someone so as to carry-out the task according to his own vision. Also, it is one of the main mechanisms through which farmers' education and rural people's knowledge is passed down from one generation to the next. Firstly, delegating requires demonstrating how to do a task. Secondly, trusting the other person's abilities and skills to carry it out implementation.

3.4.4. Multiple objectives

It has been demonstrated that the decision making process usually involves the existence of multiple objectives (Gasson 1973; Romero and Rehman 1989; Perkin and Rehman 1994) associated to conflicts and commitments which must be balanced (Giles and Stansfield 1990). As Gasson (1973) pointed out, farmers' objectives can be instrumental (related to the farm as a business), intrinsic (related to his own perception of the job), social (related to the family and the community to which he belongs) and personal (related to his personal aims). Until now, most of the attention has been focused on the instrumental objectives related to production control the system in order to obtain physical and economic results. It is clear that the objectives of the FD-MU (farmer, family and "trusted people") are complex and diverse, and that they include personal, family, social, cultural and economic elements. It is necessary to reach a balance between these areas (Robinson 1983). According to Errington and Gasson (1994) multiple objectives are the result of the dynamic and evolving process of negotiation within the FD-MU. The arbitration process involves more than one actor in the decision making process, each of whom has a different set of beliefs, perceptions and objectives.

3.4.5. Evolutionary dynamics of objectives

The objective of the FD-MU will be affected by each components' main characteristics such as age, education, knowledge, beliefs, traditions, cultural and ethical values. (Gasson 1973; Fergusson 1984; Fairweather and Keating 1990, 1994; Gasson and Errington 1993; Perkin and Penny 1994; Dent 1994). New challenges, and pressures coming from the working environment and from the different demands and aims of the FD-MU members lead to objectives being permanently adapted to new and changing conditions (Gasson and Errington 1993; Petit 1994). Therefore, there is clear interrelationship between the features of decision maker, the family and the "trusted people" within the FD-MU. This interrelationship will determine how the objectives will be fulfilled (Gasson and Errington 1993).

It is not just a problem of multiplicity of objectives as unpredictable changes in the working environment, the family, the "trusted people" and the production system will affect the decision maker's perception of the system over time. This change in perception leads to a adapting process of the objectives in the FD-MU in which some goals will change over time, enforced by the evolving internal and external forces of the whole system. Therefore, the objectives evolve within a dynamic feed-back process where the goal levels of the FD-MU will be affected by personal values[6] and beliefs, farm family knowledge, cultural and education levels, tradition, size of the family, and so on.

According to Gasson (1973) values are more permanent than objectives and less liable to change with time and circumstances. Therefore, it could be assumed that it

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[6]Values are defined by Gasson (1973), *as a conception of the desirable referring to any aspect of a situation, object or event that has a preferential implication of being good or bad, right or wrong. Values are felt to be justified by reason, moral or aesthetic judgements.*

is necessary to identify the main values and beliefs of the farmer, the family and "trusted people" in order to understand the FD-MU. The objectives emerge from the interaction between values and beliefs on the one hand, and the ever changing circumstances that the FD-MU is faced with, on the other.

3.4.6. Intergenerational concerns and family cycle

The intergenerational relationships in farming decision-making is another important, issue given the fact that "*the farm is five times more likely than other family businesses to be passed from generation to generation*" (Labvand and Lentz cited by Keating and Munro 1989). The family is a dynamic subject of study, where changes and decision are continually made. According to Gasson and Errington (1993):

> "*the primary aim of many family businesses is not to maximise profits but to maintain control and pass on a secure and sound business to the next generation*".

The incidence of the family cycle on farm objectives is well recognised in the literature (Boehlje and Eidman 1984; Keating and Munro 1989; Errington and Tranter 1991; Gasson and Errington 1993; Perkins 1995). The proposed models imply that the family cycle may be divided into phases: a initial phase of establishment, a second phase of growth and a third phase of retirement. According to Gasson and Errington (1993) typically the first phase is that when the farmer is establishing the family. This phase coincides with a stage of growth when priority is given to investments. The second typical phase starts with the children reaching school age and lasts until they become grown-up and come away from parental authority. This is the time when transition between generations begins, and it is probably at this stage, that different objectives for the farm arise, some conflicting objectives and interests needing to be solved by the FD-MU (Gasson and Errington 1993). The final phase is that when the decision-maker becomes old and it is characterised by a declining inclination to make changes and take risks. Not only the decision maker but most of the "trusted people" in the FD-MU will become older. These phases may be conceived as generational waves of development on the farm (Hopkin cited by Boehlje and Eidman 1984; Perkins 1995).

The farmer, as a decision maker, follows the same pattern: first he learns mainly from his father, secondly he takes on the leadership of the farm and major responsibilities in the decision-making process and after that he passes the farm and decision-making to the next generation (Gasson and Errington 1993). The weight of each generation in the decision-making changes with the passing of time (Errington and Tranter 1991; Errington 1992). Therefore, important elements of the FD-MU are directly related to the dynamics of the family and the "trusted people". These dynamics will be related to the age, knowledge, education, awareness, etc. of the people that comprise the FD-MU. Family business objectives are then affected by family events such as marriages, the birth of children, the education of the children or the death of the parents (Perry *et al.* 1995), as well as by the search for opportunities in the new generation.

According to Gasson and Errington (1993) an important issue in the farm family business is associated to long term objectives. As a result, some investments, such as land purchasing, can be better explained in an intergenerational context. One of the major issues in farm management and economic literature in Uruguay relates with the development of policy measures which encourage farmers to adopt new technology and attempt to persuade them against the will of many farmers to purchase extra land (Vassallo, Rubio and Methol 1987). This indicates a lack of understanding of farmers' long and short term objectives as considered under the classical economic and technological paradigm.

The nature of these evolving changes is associated to the evolving features of the FD-MU. In this study, an evolutionary perception of the process is presented as a most suitable generic framework to improve the understanding of the FD-MUs' decision-making processes and their dynamics (Nelson and Winter 1982; Andersen 1994; Allen 1994).

3.5. Relationships between household and farming systems

'Household' is not an abstract concept. Different types of approaches have been made in order to study the relationship between the household and the production systems. Fresco and Westphal defines farm household (1988) as being:

> *"like a group of people, often related, who individually or jointly provide the management, labour, capital land and other inputs for the production of crops and livestock, ...".*

Obviously, the way in which human and production resources are combined is going to be strongly affected by the socio-economic aspects related to the household.

> *"the adoption of innovation depends on decisions made on farms and the decisions are determined by goals. Decision-making oriented research considers the family, the farm and the household as one system"* (Doppler 1989).

There have been many attempts to classify farming systems and households in Uruguay. During the 1950's until the 1970's the variables most commonly used to classify farmers and production systems were structural (CLAEH-CINAM 1963, Uruguay OPYPA-CIDE 1967, Uruguay Instituto de Economia 1969). Taking the information from the Census, farmers were classified as big, medium and small, according to the size of the farm. This classification did not take the family into account. Other studies, (Uruguay DIEA 1979) provide a better explanation incorporating household requirements and defining the basic unit of production as the minimum amount of land required in order to provide enough income to satisfy the family's basic needs. These concepts were so dependent on the climate and the price of products that are now only used as indicators of short term conditions.

Considering how farm resources are organised, other authors in Mexico and in Uruguay developed a typology and identified three main types of farm-household patterns (Schejtmann 1982; Alonso and Pérez Arrarte 1982). The three main groups defined are farmer entrepreneurs, transition farmers, small farmers or peasants. The household as a unit of analysis was mainly used to better understand the peasant economies. In 1920, Chayanov (1974) developed one of the first models of household behaviour. He focused his attention on the demographic structure of the farm household and labour relationships. In fact, he developed a demographic model of household decision making. His main contribution was on a point about the existence of a different rationality and behaviour in farm decision making. He pointed out that farm decision making is not determined by economic interest and markets laws. Despite his seminal contribution, the model had no predictive power relating to factors that affect the production function, and has generally not been found useful for policy purposes (Ellis 1993).

Other authors (Fresco and Westphal 1988; Castillo 1989; Murmis 1980) mainly looking into the degree of integration of the farm with the market, identified three main farming systems: subsistence oriented systems, market oriented systems and off-farm oriented systems. Some anthropologists, mainly working with peasants, argued that the production process and land distribution are not necessarily ruled by economic interest and that farmers are more related to non-economic aspects such as family, tradition, etc. (Heynig 1980, 1982). Harwood (1979) identified four systems and states of development on small farms: Stage I; Primitive huntinggathering, Stage II; Subsistence-level crop and animal husbandry, Stage III; Early consumer, Stage IV; Primary Mechanisation.

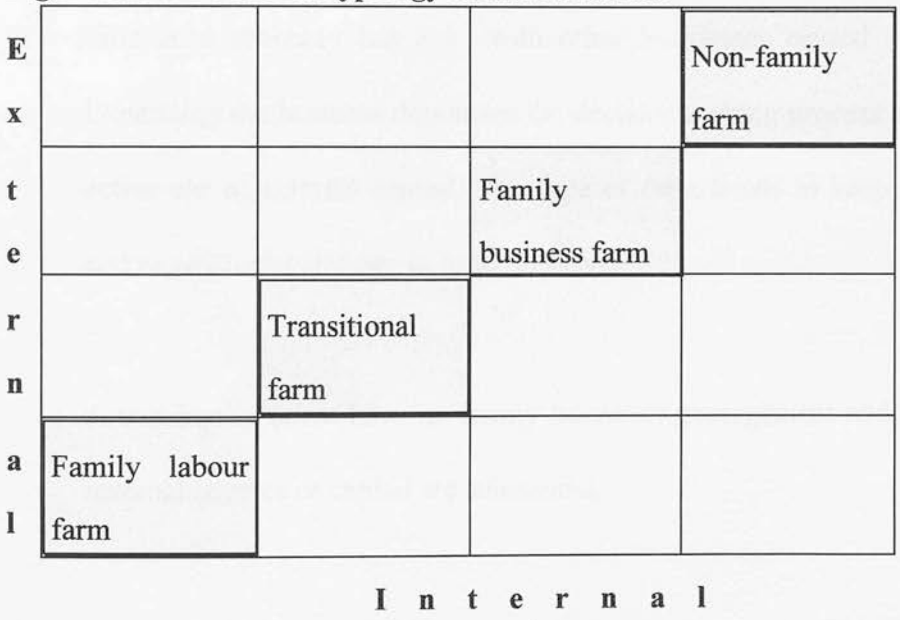
The interest here is to show the strong relationship between the farm family and the production system's classification. Obviously, the decision-making pattern in each of these groups or phases will not be the same, and the production system classified is the result of past decision-making processes developed at farm level given the objectives, needs, resources, constrains, beliefs and ethical behaviour of the FD-MU.

Previous research (Cancian 1972, 1980; Miracle 1968; Dillon and Anderson 1971; Wolgin 1975; Moscardi and de Janvry 1977; Dillon and Scandizzo 1978; Binswagner 1980; Herath 1980; Huijsman 1986 cited by Smidts 1990) using a risk analysis approach, found some evidence of small farmers being more reluctant to adopting technology because they are more risk adverse than medium or larger counterparts. This type of farmer uses rules, based mainly based on norms and community, and local or regional cultural values and the farming knowledge being passed down from one generation to the other.

Based on those interpretations, it was assumed that all farmers who own large farms are more entrepreneurial, market oriented and that their behaviour is driven by a normative approach, their rationale being oriented towards maximising their objectives whilst small farmers show an economic "irrational" behaviour.

Marsden et al. (cited by Gasson and Errington 1993) working in five areas in England, elaborated a classification of farms, on the basis of the degree of subsumption to internal and external relations. The *internal relations* represent the use of capital to control internal relationships of production (such as property rights, farm management control, working capital ,etc.). External relations relate to such aspects as adoption of new technology (buying external inputs), and the use of credit and market links. The four types suggested are presented in Figure 3.1.

Figure 3.1. A relational typology of farm business



Source: Marsden after Whatmore 1991 a (cited by Gasson and Errington (1993)

According to this typology:

1. family labour farms are almost closed systems where production relations are mainly controlled by the family. The production system of these small

businesses is based on minimum use of external inputs and capital. The strategy applied in order to maintain the farm, is low household consumption and low participation in markets.

2. transitional farms, are owned and controlled by families. It is suggested that this type of farm probably employs some non-family labour and the long term survival is associated with decisions linked to external capital support.

3. family business farms have a more complex internal functioning structure. This farm probably has links with other businesses owned by the family. Expanding the business dominates the decision making process and there is an active use of external capital. This type of farm needs to keep up a dynamic and expansionist strategy in order to survive.

4. non-family farms have no family labour or management and the links with external sources of capital are substantial.

As presented in this typology, farmers use different strategies in order to survive and to maintain their farms. The important point is to identify the main strategies and decision support systems used by the different types in order to survive and grow.

The evidence presented by Gasson and Errington (1993),

> *"suggest that while farm businesses are undoubtedly being penetrated by outside sources of capital, levels of subsumption are generally low. Large numbers of family farms are apparently managing to resist being taken over by external capital, or else they are adapting to its demands without destroying the integrity of the family business. In other words the evidence does not generally support the direct subsumption argument."*

In the study of this thesis empirical evidence will be presented to show that in the case of ELPS, even the largest farmers do not base their decisions on normative economic behaviour.

Most of the studies related with decision-making adopt a static analysis and, for this they treat decision-making and the decision maker as two different, static, abstract concepts. But decision-making is a process and when a relevant decision is made, the whole household/production farming system is affected. Stronger than the differences among production systems is the difference in traditions, beliefs, cultural and ethic values which explain the differences among production systems (Olivier de Sardan 1994) .

3.6. Knowledge for decision support

The level of knowledge in farming communities is frequently related to the level of formal education. There is a great deal in literature about the importance of the level of education and training in the human capital development (Hayami and Ruttan 1985; Wignaraja *et al.* 1991; Hofsteede 1990). It is one of the most significant elements to be considered in a process of change in rural development. Studies (Sing and Ray 1980; Vijamakumer 1985; INIA 1991, 1992) show that the level of education of the decision maker and his family is a very important factor in determining the attitude to change. The difference in relation to adoption of new technology has been associated with the education level.

A survey done by INIA shows that 41% of the farmers with higher levels of education are more inclined to adopt new technology against 24 % among those with a lower level of education. (INIA 1991). Farmers who have reached education levels up to the completion of high school are more keen to adopt new technology (INIA 1992). The education level is also considered important because the adoption of new techniques implies a change in system where additional knowledge is likely to be required. It has been found among non-farmers that intensive short-term courses can increase the motivation and hence business growth (McClelland and Winter 1969; Hirbar and Law 1976 cited by Fergusson 1984).

However, these studies have been concentrated on formal education and no attention has been paid to the knowledge gained in interacting with the working environment in the widest sense. Farming communities have been adapting their practices, changing conditions over long periods of time and, today, the importance of local farmer knowledge is recognised (Chambers, Pacey and Thrupp 1989; Haverkort and Zeeuw 1991; Dusseldrop and Box 1993; Millar 1993; Scoones and Thompson 1994; Röling 1994). It appears to be clear that knowledge plays a key role in determining people's behaviour in relation to changes, therefore a process of agricultural development needs to search for complementary traditional and scientific knowledge (Röling 1985, 1992; Funtowicz and Ravetz 1993).

3.7. Rural people's knowledge and information networks

Information is not distributed in the same way to all decision makers in society. Stochastic variations in the working environment and informational imperfections generate differences amongst decision makers (Nelson and Winter 1973, 1974, 1982; Nelson, Winter and Schuette 1976). Furthermore, there are also differences among decision makers in their capacity to transform information into knowledge and therefore decision makers are not faced with the same set of choice alternatives. Decision making problems at farm level are usually complex (Röling 1994) and associated with the concepts of risk[7] and uncertainty[8]. According to Humphreys and Berkeley (1983) people prefer to "play safe" or to follow "safe routes" selected by their previous experience, knowledge and the available information.

The Transfer of Technology approach is focused on how to transfer scientific and technical knowledge to farmers (Rogers 1983). Today, it is increasingly accepted that, in order to facilitate sustainable development, technical information alone is not sufficient; improvements in information for decision making needs to come not only

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[7] A decision is considered risky when the decision maker does not know for certain the results of his decision but has an estimation of the relative chances of different scenarios resulting. In other words, it is a situation in which the farmer knows the probabilities of the alternative courses of action

[8] uncertainty is a situation in which the farmer can not specify the probabilities (Cancian 1980; Smidts 1990; Douglas 1986 and Fleisher and Robison 1983).

from records, books and advisers, but crucially also from the context of the agricultural production system, internalised farmer and family information flows (Röling 1994; Dent 1994) and interpersonal communications networks.

In order to cope with uncertain farm problems, the FD-MU develops a strategy in order to obtain relevant information to support their decisions. Farmers develop a structure of personal indicators to observe and be involved with networks (Haverkort and Zeew 1991; Röling 1994) where a multiplicity of "local standards" are developed by trial and error and used later for support in decision-making.

Some recent studies have shown that at farm level, most of the information and knowledge used to support decision making comes from personal networks (Haverkort and Zeeuw 1991; Röling 1994), where "trusted people" play a key role. This knowledge, naturally produced in a local area and used as decision support has been defined in literature using different terms and concepts. Chambers, (1983) describes the following terms: indigenous technical knowledge [ITK], local knowledge (Geertz 1983), indigenous knowledge, people's science, local knowledge, ethnoscience, rural people's knowledge [RPK], that have been used in the literature to describe the knowledge used by people as a different source of knowledge, which can be contrasted with modern scientific knowledge [MSK]. In this research is used Chambers's (1983) concept of rural people's knowledge to refer to farmers knowledge and local knowledge to contrast with urban knowledge mainly urbanely oriented. Rural People's Knowledge [RPK] is defined by Chambers (1983) as:

> *"the knowledge of people and existing system of concepts, beliefs and ways of learning. Includes both small and large farmers. The knowledge is located in people and only rarely written down. Knowledge refers to the whole system including concepts, beliefs and perceptions, the stock of knowledge, and the processes whereby it is acquired, augmented, stored and transmitted."*

Cultural values and rural people's knowledge [RPK] are part of the individual. The key role of RPK in identifying and finding solutions for some problems is now increasingly recognised (Heinemann and Biggs 1985; Wignaraja 1991; Dusseldorp and Box 1993; Chambers 1983, 1989, 1993; Salas 1994; Drinkwater 1994; Portela 1994).

> *"...endogenous experience-based learning, which is predicated on having gotten beyond the innovation stage, is an important source of technical developments..*(Furthermore)*...emphasise that the information contained in papers, patents, blue prints and other forms of codified knowledge often will not be sufficient to implement technology in question. Complementary know-how is required.."*(David 1992).

RPK (Chambers 1983) has been increasingly used for the identification of medicinal plants (Mbewe 1994), for the agricultural research and extension problems' identification and for the development of solutions (Wellard 1993; Prain 1994; Cornwall, Guijt and Welbourn 1994), for resource management (Mascarenhas 1994), for decision support systems in ecological resources management (Genotal 1992), for pest control (Bentley 1994; Winarto 1994), for genetic resources conservation (Worede and Mekbib 1993), and for developing sustainable plans (Haverkort and Zeew 1991; Thrupp, Bruce and Zazueta 1994).

It appears that the knowledge systems approach to better target research and extension problems could create conditions which would stimulate the search for effective alternatives for sustainable agricultural change (Röling 1994, Mielgo *et al.* 1996; Bellon *et al.* 1996).

3.8. Summary of considerations

In this Chapter, some basic ideas about the decision making process at farm level were presented. The way in which decision making at farm level is understood will have important consequences in the development of decision support systems. Early works on decision making, under the normative perspective were focused on the understanding of simplified and static problems considering the decision maker as an individual who based decisions on a rational and objective cost-benefit analysis of the different activities considered (Section 3.3.1).

Problems and limitations found during the use of "normative rational models" to support decision-making reinforced the development of other ideas where socio-economic and political factors that surround the decision making process at farm level were explicitly considered. Another approach presented is the behavioural perspective that supposes that individuals try to satisfy their objectives rather than follow a maximising behaviour (Section 3.3.2). The most cited model for decision making understanding in this perspective was proposed by Simon (1955, 1957, 1983). As presented, this model is based on a "satisficing" behaviour, where the decision maker acts according to a bounded rational behaviour (Section 3.2.2). The behaviourist school is based on a broader and more realistic conception of the process. Behaviourists argue that the problems which the decision-maker is faced with in real life are complex and, therefore, it is not possible to have perfect information in order to maximise the objective over a pool of possible alternatives. According to this approach, decisions are based on bounded rationality (Simon 1955, 1957) where the complexity of the problems do not allow for optimisation as it is not possible to have perfect information, knowledge and understanding to make perfect decisions. For this reason, decisions are based on simple rules and procedures to guide the actions in order to satisfy the global objectives of the system. To better understand these rules, they suggest that computer applications are a useful approach to represent their theoretical models (Cyert and March 1963).

It was stated in the Chapter that some "models" and techniques -essentially normative in nature- were developed to support decision making,. These tools help the decision-maker achieve what is considered the main objectives in a normative approach:(profit maximisation first and utility maximisation later) within a framework of perfect information. The majority of these models does not assume that decision making is a complex and dynamic process where the evolution of human factors (farmer, family and "trusted people") and relationships (kinship, marriage, partnership, friendship) play a key role on the perception of the production system and the working environment (Section 3.3.3).

Another approach presented is that of the evolutionary economists (Nelson and Winter 1982; Possas 1989; Andersen 1994; Allen 1994). Many of the principles used by the behaviourist school (Bobbitt *et al*. 1974; March and Simon 1958; Herzberg 1959; Porter and Lawler 1968) are absorbed into this analysis (Nelson and Winter 1982). According to the evolutionary approach, decision making is understood under an evolving set of circumstances where: i) the objectives driving the system are multiple, vaguely defined and sometimes conflictive, and ii) decision making is mainly based on heuristics and "rules of thumb" acquired through the interaction with the working environment. It seems that this approach provides a better basis for the understanding of the dynamics of the farm decision making process (Section 3.3.4).

Section 3.4 introduces the concept of FD-MU that appears to allow for a closer understanding of the decision making process at farm level as a unit of planning, management, control and resource allocation. It was hypothesised that this unit is comprised of the farmer, some members of the immediate family and some elements of the "trusted people". These FD-MUs have multiple objectives that are the result of the dynamic and evolving process of negotiation within the FD-MU. The family cycle's evolution also has strong influence on the evolution of farm objectives. It was also suggested, according to the literature, that decisions at farm level are certainly not orientated to maximise economic outputs or a single clear and unique objective (Section 3.4.).

The literature review suggests that, in order to cope with the stochastic variations in the working environment, the FD-MU has developed different knowledge, information search routines, decision support systems (e.g. trusted people) and strategies to support decision making, that are the consequence of an evolutionary adaptive behaviour (Sections 3.5, 3.6 and 3.7). The experience gained by the FD-MU through the actual production and management practices in repeated interactions between the production system and the working environment generates incremental information and knowledge. There is a need to include farmers' informal adaptive research and RPK in formal research and extension programmes (Heinemann and Biggs 1985; Sebillotte 1994; Campagne 1994; Toulmin 1994; Darré 1994). Knowledge as technology is one of the most important factors for development (Cobbe 1993).

Therefore, there is a strong relationship between the household evolving objectives and the farming systems. The review of different approaches developed in order to study the relationship between the household and the production system was also presented (Section 3.5). However, most of the studies and typologies developed in order to understand the decision making process have been mostly static and refer to the decision-maker as an individual. However, there is some evidence that decision making at farm level is a dynamic process that involves more than an individual.

The hypothesis is that the theoretical background of evolutionary economics and the behaviourist school provide a better framework to better understand FD-MUs' decision making compared to the static neo-classical analysis.

Chapter 4

An Evolutionary understanding of the decision-making process

4.1. Introduction

In this chapter, some basic concepts about the need of an holistic and evolutionary understanding of decision making at farm level taking into consideration farmers' diverse behaviours will be presented.

Under a traditional research approach, evolutionary, continuous and dynamic processes are often reduced into mechanistic and static (Millar 1993). Research and extension funding and support to farmers have been focused on the transmission of isolated technologies in traditional areas of production under the assumption that technology is neutral with regard to farm size, type, location, etc.(Hildebrand 1986; Lynam 1993). This Transfer of Technology [TOT] approach (Rogers 1983) features scientific push where the needs are defined without explicitly considering the real users (Chambers 1983; Cobbe 1993). Social factors are considered irrelevant in building knowledge (Röling 1994). The failure of this approach is attributed to a lack of understanding of the real needs of farmers and the decision making process at farm level (Dent 1994).

The decision environment at farm level is complex and it is therefore necessary to simultaneously integrate biological systems, FD-MU perceptions and constraints, social factors and economic conditions (Stuth *et al.* 1991). It is now accepted that useful knowledge for sustainable development needs to be considered in a more holistic way, where knowledge not only comes from experiments and research, but also from the local capacity of farmers for solving complex and locally perceived problems, needs to be considered (Chambers 1983; Fujisaka 1994; Darré 1994; Campagne 1994).

The evolution of social factors (economic and socio-cultural) as well as past experience of the FD-MU have a major influence on the acceptance of new ideas and will affect the behaviour to technical change and therefore the rate of adoption of new technologies (Lynam 1993).

It appears that research and extension can be better targeted if FD-MUs are classified into homogeneous recommendations domains according to their agroecological, socio-economic (Heinemann and Biggs 1985; Williams 1994) and decisional characteristics.

4.2. Towards an evolutionary understanding of decision making

An evolutionary approach attempts to explain the diversity and adaptability of decision rules, production methods and organisational forms of economic life by the description of endogenous change. Variation and selection are the main mechanisms that drive change in an evolutionary process (Andersen 1994).

FD-MUs develops adaptation mechanisms to cope with internal and external dynamic changes, attempting to cover first, the survival and security needs (Stuth *et al.* 1991; Perrot and Landais 1994). An evolutionary interpretation assumes the existence of mechanisms of: preservation of the FD-MU based on the maintenance and transmission of proven past information routines and knowledge search and use; creation of new routines of information and knowledge search and use; and the selection and copy of successful routines of information and knowledge search and use (Vromen 1995).

4.2.1. Mechanisms of evolution

Reggiani and Nijkamp (1994), argue that there are two main mechanisms of evolution: i) continuous evolution, based on Darwinian (1859) (cited by Reggiani and Nijkamp 1994) ideas, where changes are gradually introduced and ii) the discontinuous evolution, the ideas of Wright (1931) (cited by Reggiani and Nijkamp 1994), where changes are produced as a consequence of dramatic changes in the working environment which force the introduction of major changes to cope with this new environmental conditions. However, Boulding (1978) (cited by Reggiani and Nijkamp 1994) is in favour of a mix of continuous and discontinuous evolution.

Schumpeter (cited by Andersen 1994) points-out that the evolution of technical change can be explained by both gradualist evolution and exogenous shocks.

Andersen (1994) based on Schumpeter ideas describes the mechanism of "punctuated" evolution to explain change. The scheme is based on two basic abstract operators that have a specific role in the evolutionary process, the α-operator, propelling evolution and the β-operator working towards a non-evolutionary state (Table 4.1).

Table 4.1. The function of the operators of evolution

	G-set	F-space
α-operator	Introduction of new routine types.	Creation of disequilibrium
β-operator	Possible removal of old routine types	Movement towards equilibrium

Source: Andersen (1994) p. 37

He defines a system of routine-based behaviour and describes the action at two levels. The **G**-set level, that represents the changes in the set of types of routines and the **F**-space, that represents the changes in the frequency of these routines.

According to this scheme, the creator of evolutionary change is represented by the α -operator, the β-operator being the creator of movement towards equilibrium frequencies of the different routines. If one of the operators becomes totally dominant, there is no evolution, because the dominance of the α-operator leads to confusion and disorder and the dominance of the β-operator leads to stagnation.

Therefore, according to this scheme, the evolutionary process alternates between states of stagnation and processes of change that are mainly impelled through knowledge and innovation as a response to external or internal changes.

Based on this scheme, it can be suggested that in the agricultural sector, some FD-MUs will behave introducing technical changes in their production system through the introduction of gradual improvements related to research or innovation of other farmers, others will continue using their traditional routines and some others will introduce technical changes only when some relevant external or internal event takes place.

So, it is possible to assume that the main types of FD-MUs behaviours are:

- proactive FD-MUs with innovative behaviour, introducing changes gradually,

- reactive FD-MUs, that have mainly an imitative behaviour and will change their farm production system only when big changes occur, and

- Passive FD-MUs that do not change their traditional routines and maintain the rules and information search routines frequently used.

As presented, each FD-MU will adopt different behaviour and decision making mechanisms related to technical change according to their own convenience. So, it is possible to suggest that behind each FD-MU behaviour it is possible to find different decision support processes. Therefore, it appears that decision making is not a process developed by each FD-MU in isolation, because the interaction and communication with other FD-MUs appears to be relevant (Haverkort and Zeeuw 1991; Cornwall *et al* 1994).

Adapting Schumpeter concepts to the agricultural sector it may be suggested that a significant process of change in the frequencies of the different FD-MUs behaviours is most likely to happen when external or internal events force them. Thus can be explained because FD-MUs with a preservation instinct (the majority) will apply the same routines until a major event in the working environment produces changes of a magnitude for which the old routines no longer achieve good solutions (Vromen 1995).

4.2.2. Farming Behaviour and DSS selection process

The main mechanisms that drive change in an evolutionary process are variation and selection (Andersen 1994). The above considerations indicate that FD-MUs populations are essentially diverse in terms of the behaviours adopted related to technical change (Collinson 1982; Byerlee 1987; Williams 1994). The different combination of ecological, demographic, market, political, ethical, cultural and socio-economic conditions at farm level generates different FD-MUs behaviour to change (Long and Villareal 1994). These FD-MU behaviour to change and their ways to support decision making are gained through experience, coping, learning and adapting how to drive the farm family system in a changeable working environment. That is, the FD-MUs have adopted natural routine procedures for decision making and the control of the tasks associated to the management of crops, animals and pastures (Ison 1993; Papy 1994).

It appears, that a factual relation between the FD-MUs actions, and the system response subject to the forces of the working environment, is established through an iterative feed-back process of trial-and-error.

> *"at the level of individual firms, the crucial element of change is full recognition of the trial-and-error character of the innovation process ...* (This occurs) *through processes of deliberate problem solving perhaps involving some imitation of the observed success of other firms". "Or it may 'just happen,' as particular capabilities in the firm improve through use (learning by doing), deteriorate through disuse or are adapted to changed input characteristics* "(Nelson and Winter 1976).

So, through an information feed-back mechanism the FD-MU gains understanding through the system they are driving, such as: estimate the variation of the grazing carrying capacity of the farm during different seasons; pasture production associated to weather variations; number, type and age of the animals grazing that can be fed under these conditions (Frank 1995).

The Agricultural Knowledge and Information System

In 1990, Röling and Engels, based on a systems perspective and the work of different authors, developed the concept of Agricultural Knowledge Information Systems (AKIS). He defines the AKIS as:

> *"the set of organisations and/or persons, and the links and interactions between them that are engaged in, or manage such processes as the anticipation, generation, transformation, transmission, storage, retrieval, integration, diffusion and utilisation of agricultural knowledge and information, which potentially work synergically to support decision making, problem solving, and innovation agriculture or a domain thereof."*

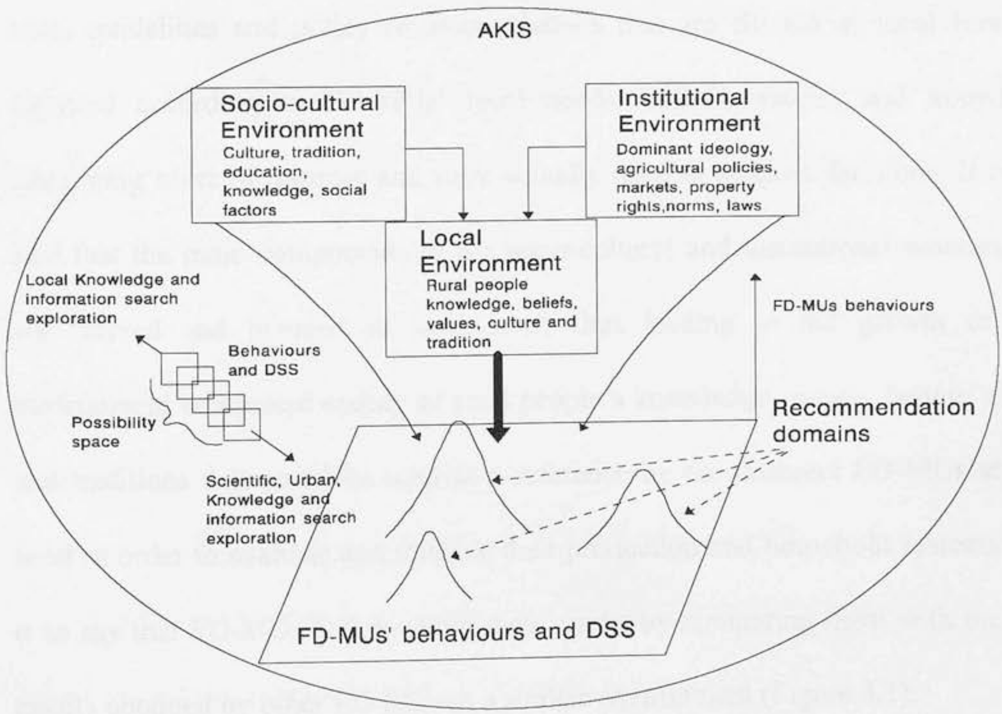
The AKIS model provides a conceptual framework to better understand the links among the different existing institutions such as research, extension and farmers (Röling and Engels 1990). This work is focused on the knowledge and information actually used by farmers in order to support their decision making process.

Knowledge and Information Selection Processes

In order to make decisions, FD-MUs will search for information and knowledge from the most frequently used sources (Figure 4.1). Scientific and rural people's knowledge coexists at the same moment in time in the AKIS. As presented, farmers, in their interrelation with the environment, have been developing routines to solve problems totally or partially integrating these types of knowledge and information to support their decisions (van Dusseldorp and Box 1993).

The socio-cultural and institutional environments dominant of the country will send their messages and information flows through farmers. Farmers will perceive and evaluate these messages and information based mainly on their dominant rural people's knowledge, beliefs, values, culture and traditions in their local environment (Figure 4.1). Mass media, extension services, agricultural research, commercial media, and rural people's knowledge will be some of the sources of information that the different FD-MUs will search for in order to support their decision making. In order to make decisions, FD-MUs will explore different information sources and available knowledge (urban, scientific, local, rural, formal, informal, etc.) and will select those that, according to their perception, can fulfil their objectives better (Figure 4.1).

Figure 4.1. FD-MUs evolutionary adaptation process



Adapted from Allen (1994).

Figure 4.1 represents a "possibility space" of information and knowledge availability. The "possibility space" is defined by Allen (1994) as:

> *"a space representing the range of different techniques and behaviours that could potentially arise for the different types of firms present".*

This is the space that represents the range of different rules, routines, techniques or practices developed on the basis of scientific knowledge and/or rural people's knowledge at local level; and the FD-MUs' behaviours and DSS that could arise in the dynamic process of evolution for the different types (Allen 1994). This "possibility space" is mainly determined for the type and availability of knowledge in the AKIS (Figure 4.1).

So, the general socio-cultural and institutional environment of the country gives the main guidelines and policy recommendations that are filtered at local level and adjusted according to FD-MUs' local needs, beliefs, values, and knowledge, generating a set of routines and rules actually used to support decisions. It can be said that the main components of the socio-cultural and institutional environments are filtered and blended at local level, thus leading to the growth of local environment comprised mainly of rural people's knowledge, values, beliefs, culture and traditions that could be used as a reference by the different FD-MUs at local level in order to evaluate and monitor their production and household systems. That is to say that FD-MUs will evaluate their results by comparing them with the main results obtained by other FD-MUs in a similar environment (Figure 4.1).

> *"by updating their traditional knowledge farmers adapt their practices to a new agricultural context"*(Bellon, Chabert and Blic 1996).

Under a TOT approach, extension efforts are concentrated on the removal of the old routines used by the FD-MUs without considering the diversity of situations. The TOT approach is still the dominant one and inspires institutions such as research, extension and agricultural education. This TOT is supported by strong networks composed by agricultural research, extension scientists and workers linked to the agroindustrial sector represented by the seed, herbicide, pesticide, and fertiliser companies (Röling and Jiggins 1996).

However, the different sources of information available will be evaluated as perceived by the FD-MU according to how useful they are in solving their problems. It may be suggested that FD-MUs with a higher level of formal education and who are more urbanly oriented will prefer to search for solutions in scientific and formal knowledge whilst FD-MUs with a lower level of formal education and who are rurally oriented will prefer to search for solutions in rural peoples' knowledge and informal information.

Behaviours and DSS diversity

The dynamics of evolution generates different and divergent behaviours and "natural" DSS, developed according FD-MU features (socio-economic needs, available resources, knowledge, values and beliefs). This diversity represents all the different behaviours and "natural" DSS developed in order to cope with the working environment at local level. Competition processes among FD-MUs lead to a selection process, in terms that some FD-MU are going to be successful whilst others will not, and therefore disappear.

> *"Evolution selects therefore, for populations with the ability to learn, rather than for populations with optimal behaviour"* (Allen 1994).

Based on Nelson and Winter (1973; 1982), Andersen (1994) and Vromen (1995) it may be suggested that FD-MUs will adopt and select different routines of information search, screening, storage, processing and analysis of information and knowledge, those that once have provided solutions considered to be satisfactory by the FD-MU will be repeated until some internal or external change force them to start a new process of change and information and knowledge search.

Therefore, can be argued that the decision making process performed by the different FD-MUs is the result of an evolutionary process of adaptation of the farmer, the family and the "trusted people" that is rooted in their socio-economic, cultural and ethical goals and values (Gasson and Errington 1993).

The behaviour of the FD-MUs population has a mean and a variance. The mean represents the central tendency of behaviour while the variance represents the distribution of behaviours around the mean (Bobbitt *et al.* 1974). Evidence shows that there is a wide variance in behaviour between individuals and therefore, the expected mean of behaviour in a community would be a difficult and perhaps misleading indicator to represent all the FD-MUs.

Recommendations domains

So, a possible alternative is to classify FD-MUs according to their pattern of behaviour in response to technical change and their "natural" decision support system features. By way of a classification procedure it may be possible to reduce the variability between FD-MUs (Byerlee 1987). This can help to identify target groups of FD-MUs into smaller and relatively homogeneous "recommendation domains" (Figure 4.1) or groups related to behaviour to technical changes and "natural" DSS for whom similar research, extension and development efforts will more certainly be appropriate (Collinson 1982). However, these recommendation domains need to be considered not as research and extension receivers, but need to be considered as an active valuable source of information and rural people's knowledge.

4.2.3. Behavioural models to explaining change and adoption

In order to provide a theoretical explanation about the main factors affecting FD-MU's behaviour in relation to the adoption of technical change, concepts of behavioural models presented in Section 3.3.2. will be expanded.

Behaviour components

Behaviour is the result of perception, motivation, learning and cognition and attitude to change (Bobbitt *et al.* 1974). *Perception* is related to the capacity to sense and interpret reality. *Motivation* involves specific action to satisfy needs. *Learning and cognition* implies the responses to change selected as a result of practice and the ways of thinking used to solve different problems. *Attitude to changes* are the feelings (positive or negative), deliberations or inclination to act towards some element of the "environment" (Bobbitt *et al.* 1974). Different models have been developed in order to represent behaviour and change, (March and Simon 1958; Herzberg *et al.* 1959; Mintzberg *et al.* 1976; Fergusson 1984; Simon 1978; Öhlmér, Olson and Brehmer 1994).

Behaviour to changes

One of the main consideration related to behaviour in response to change, are the study of satisfaction and dissatisfaction. Porter and Lawler (1968), present a direct relationship between performance and satisfaction, with the prediction that performance leads to satisfaction and change. March and Simon (1958) elaborate a model where satisfaction is viewed as a balance between expected future value and levels of aspiration. According to this model the decision-makers act according to "bounded" rational behaviour and are more concerned with the processing of past actions rather than that of forecasting the consequences of future actions. They suggest that it is dissatisfaction that has more implications for change than satisfaction.

Fergusson, (1984) based on the model developed by March and Simon (1958) analyses seven case studies on the Northern Tablelands of New South Wales (Australia); he suggests that, for a particular goal, the discrepancy between goal achievement and goal aspiration levels determine the level of satisfaction and the rate of search for alternatives. Frank, (1995) working with a random stratified sample of 68 ELPS in Dalfympple and Bowen Shires (Australia), found that when farmers feels satisfied with his achievements, the level of adoption behaviour in relation to technical change can be expected to remain low or static.

Therefore, it can be suggested that decisions that lead to change are mainly product of dissatisfaction states of the FD-MU. That is, to say that a process of change starts with a disequilibrium state in the production or household system which leads to a state of dissatisfaction in the FD-MU. In other words, dissatisfaction states are generated when the evaluation of the results (the difference between goal aspiration and goal achievements) of actions performed by the FD-MU are not achieving the expected objectives. Goal aspirations do not grow spontaneously but are constructed gradually until the moment in which dissatisfaction is produced.

So, it appears that a process of change is initiated by a dissatisfaction state, and that this leads the FD-MU into a search for new knowledge and information in order to substitute the routines commonly used to solve the problems. Once the FD-MU reached a new equilibrium, a phase of preservation takes place and again the new routines and rules for knowledge and information search will be used until a new problem appears[1]. If the routines again do not provide satisfactory solutions, a new dissatisfaction state arises and a new process of change starts again.

Adapting Schumpeter's evolutionary scheme to the model described for FD-MUs the decision making process can be described as:

- The process starts with a production system in a state of equilibrium working on the basis of FD-MUs known routines.

- The production and/or household systems are strongly disturbed and unbalanced by external or internal factors and this leads to the FD-MU being dissatisfied with their achievements.

- The internal routines of decision making used for problem-solving in each of the different production and family subsystems that integrate the farm family system are reorganised through the integration of new routines of information and knowledge search gained by a feed-back mechanism.

- The use of the new routines continue until some external or internal disturbance occurs again.

[1] E.g.,Despite the information about the benefits of supplement animals during winter, was available long time ago, was incorporated as a new management routine after the drought.

As was developed in Chapter 3 and in the preceding sections of this Chapter, farmers behaviour to technical change and goal aspiration level appear to be strongly affected by a multiplicity of factors (socio-economic, demographic, cultural, educational, and psychological) impacting on the decision-maker and the "trusted people" (Mpanya 1985; Sconnes and Thompson 1994; Gasson and Errington 1993; Gafsi and Brossier 1996). Therefore, it is possible to suggest that FD-MU behaviour to technical change is influenced by education level, skills, social pressures, family pressures, personality and age of the farmer and "trusted people" (Guerin and Guerin 1994; Gasson and Errington 1993).

Decision making dynamic control

The relation between economic, social and individual goals change permanently with time, and demand adjustments in regards to decision-making priorities. This means that the degree of dissatisfaction depends on FD-MU features, such as age, education level, skills, social pressures, family pressures, personality, status, family goals, social values and family situation, that also change with time.

It appears that the FD-MU and the personnel involved in farming tasks have developed the skills, experience and background to drive the system, based mainly on known routines which are perceived to be associated to lower degrees of uncertainty and risk (Humphreys and Berkeley 1983).

> *"Research and development and technological innovation continuously create new knowledge and uncertainty"* (Coombs, Saviotti and Walsh 1987).

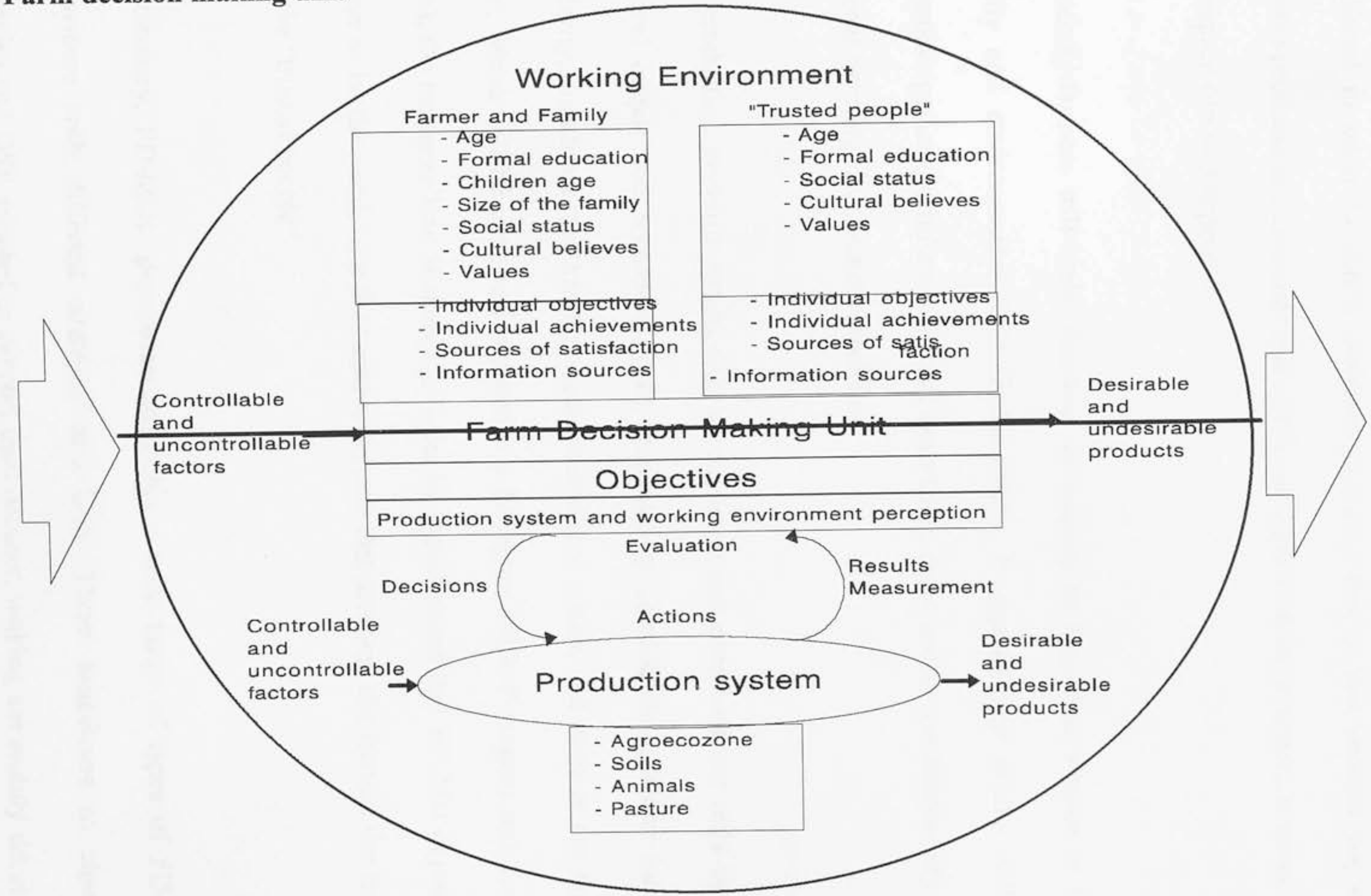
Based on the information presented in preceding Chapters and sections, it can be hypothesised that the FD-MU appears to be comprised by the farmer, the family and the "trusted people" (Figure 4.2).

As presented in Figure 4.2, the production system and working environment perception would be affected by the age, formal education, values, cultural beliefs and objectives of the farmer, the family and the "trusted people". The interpersonal communications with "significant others" (Gasson 1971) and "trusted people", the social status of the family, the level of aspiration, the beliefs and values are important factors that affect the system's perception.

> *"... the firm is an adaptive, imperfectly rational coalition of different interest groups whose bargaining processes lead to rules which may be considered as a kind of truce in inter organisational conflict. Such a firm may have considerable organisational slack which absorbs a substantial share of the environment shocks while given rules are upheld. Only when performance does not live up to the acceptable-level goals, is a problematic search for alternative rules then performed* "(Andersen 1994).

The FD-MU's perception of the production system, the working environment and the household is important in order to define the production system's objectives and evaluation criteria.

Figure 4.2. Farm decision making unit



As presented in Figure 4.2, a feed-back mechanism between the FD-MU (trying to control the production system controllable factors) and the production system is established in order to obtain desirable products. But in this process not only desirable products are obtained; undesirable products such as pollution, erosion, and bankruptcy can also appear.

Therefore, farmers will make decisions in relation to facts that happen in their locality and environmental field (Frank 1995). It appears that results will be evaluated against the information and knowledge dominant in the community and the local working environment conditions.

The production system's results will be evaluated and perceived not only by the physical output and economic profit, but also by considerations about internal solidarity, emotional ties, kinship, inter-generational issues, and stage in the family cycle, which will be important (Gasson and Errington 1993, Errington and Tranter 1991). On the same line of thinking, it can be hypothesised that FD-MU objectives appear to be the result of a deliberative process that involves the farmer, the family and the "trusted people".

In summary, FD-MUs' population comprises a wide range of types of FD-MU behaviours with different strategies and DSS. These behaviours to changes, strategies and DSS adopted to support their decision making are mainly developed according to their beliefs, values and socio-economic needs (Millar 1993).

It appears crucial for FSR/E programs to know the behaviour and DSS associated to these different groups of FD-MUs. Millar (1993) pointed out that FSR/E have had problems that appear to be influenced by factors rooted in the cultural ways used by farmers for farming more than on technical, economic or agrarian problems. The technology to be generated and to be offered by the research and extension to the different groups of FD-MU ought to be different.

4.2.4. How to integrate rural people's knowledge

Until now it has been presented that decision making at farm level is an evolutionary process where one of the main elements involved is rural people's knowledge. It also suggested that rural people's knowledge is a valuable source of knowledge for development. According to Campbell (1987) the main determinant in the generation of knowledge is change.

> *"...development and technological innovation continuously create new knowledge and uncertainty"* (Coombs, Saviotti and Walsh 1987).

This knowledge which is different from scientific knowledge, is informal and not easily accessible because it is mainly stored in rural people's minds. Most of the works for developing knowledge-based systems points out that the main bottleneck is how to acquire this knowledge (Gaines 1988; Gaines and Boose 1988). The relevance of rural people's knowledge for development has been recognised in the strategy of the Agenda 21 (1993) as co-ordinated by the United Nations Commission on Sustainable Development in Rio de Janeiro (1992) that recommends, integrates, compiles, and analyses information on rural environmental and developmental people's knowledge and assist communities to benefit from it.

That points out that rural communities need to be seen not only as consumers of new technology generated on research institutions, but as whom also have valuable knowledge and expertise transmitted and generated in the process of adaptation of farmers communities with the working environment (Rhoades 1993; Maurya 1993; Prain 1993). Farmers communities imply multiple actors, multiple knowledge and multiple, types of information. Also, not all rural people's knowledge is useful.

It appears that methodologies where farmers, family and the community participate actively can be used to identify real farmers problems and possible solutions for development. A wide review of participatory approaches is presented by Cornwall *et al.* (1994). Participatory methodologies appear to be promissory in order to address farmers' needs and adjust technology to their particular environmental conditions (Heinemann and Biggs 1985; Wignaraja 1991; Weber and Ison 1995).

The interest here is not to describe the different participatory methods, but to point out the need to develop new interfaces between agricultural researchers, extension workers and farmers in order to find the ways for socio-economic and environmental agricultural development.

It appears that a classification of FD-MUs into recommendation domains can play a key role to establish target groups for understand decision making behaviour to technical changes, identify the information sources and routines used for support decisions and acquire rural people' s knowledge and information through an active participation of the FD-MUs.

4.3. Summary of considerations

This Chapter presents the main ideas which can support an evolutionary understanding of the decision making process. The focus is on the explanation of the main mechanisms of evolution that may be associated to the main behaviour and decision support systems adopted by the farm family systems, emphasising on technical change and innovation. As presented, an evolutionary understanding implies diversity and adaptability of the economic agents.

According to the literature, there are two main mechanisms of evolution; one that assumes that changes are gradually introduced and another that supposes that changes are produced as a consequence of dramatic changes in the working environment which force the introduction of major changes in order to cope with the new environmental conditions. However, there is another interpretation which explains technical change by both gradualist and exogenous shocks (Section 4.2.1).

According to the literature, these mechanisms of evolution force the FD-MU population into adopting mechanisms of preservation. It was pointed out that through an information feed-back mechanism the FD-MUs will gain an understanding of the system they are driving and their capacity to react. According to how the FD-MU reacts, it was possible to assume that there are three main types of FD-MU behaviour; i) the proactive, which reacts introducing changes gradually, ii) the reactive which will introduce strategic changes only when big changes occur and iii) the passive where the mechanism of preservation is to maintain traditional routines and rules and, therefore, do not change (Section 4.2.1).

In order to provide an understanding of the inner mechanisms of the decision making process, the main behavioural models to explain change and adaptation were also shown (Section 4.2.2). The literature review suggests that the main factor in order to explain change is a state of dissatisfaction. Then, based on this assumption, an evolutionary understanding of the FD-MU decision process towards change was suggested. This process starts with a state of equilibrium in the farm family system, that is disturbed by an external or internal event which promotes a state of dissatisfaction in the FD-MU leading to change. Once a new equilibrium is reached, the routines are maintained by the FD-MU until a new state of dissatisfaction sets in starting a new process of change. As has been presented this far, there are important connections in the FD-MUs behaviours that could be better explained in the light of the behaviourist and evolutionary approaches rather than by the static and single objective neo-classical approaches.

An important consideration made by Allen (1994) is that through this iterative process, evolution selects populations of FD-MUs who have the ability to learn and generate new knowledge in order to adapt to the internal and external changes, rather than populations with optimal but fixed behaviours (Figures 4.1 and 4.2). The FD-MU will adopt and select different routines, information and knowledge, and those considered satisfactory will be repeated until some internal or external event forces them to change. Therefore, one of the main products of the decision making process is the new rural people's knowledge generated in a trial-and-error process of interaction with the working environment. Section 4.2.4 presented the relevance of integrating rural people's knowledge in order to assist the process of agricultural development. It seems that these RPK could be acquired through participatory approaches that allow for the identification of the information flows actually being used to support decisions.

FD-MUs are not homogenous; they are diverse and dynamic not only in reference to their production systems, but they are also diverse in their behaviour, knowledge and "natural" decision support systems. The demographic, cultural, socio-economic, ethical and ideological factors will dynamically affect their beliefs, values and goals.

It was also shown that, in the process of adaptation, farms' population have different behaviours to technical change and could therefore be classified into different sub-population types or "recommendation domains".

It appears that by identifying and classifying the main behavioural types of FD-MUs related to technical change, and by finding out what their mechanisms for supporting decisions are, "recommendation domains" could be defined. These relatively homogeneous "recommendation domains" can be useful for research and extension not only to better target research, but also as an active, valuable source of information and rural people's knowledge. It is possible to better understand the different FD-MU behaviours to technical changes and the real and active decision support systems by using these "recommendation domains". In this way, it will be possible to identify what actions and tools could be developed, if necessary, in order to build up interfaces that can encapsulate rural people's and scientific knowledge to provide better support in favour of FD-MUs' decision making.

This research develops a methodology to identify and analyse different "types" of FD-MUs and the decision support systems and behaviours associated to each of them (Chapters 6, 7 and 8).

Chapter 5

Towards an understanding of farm decision making unit's decision support systems

5.1. General Considerations

As presented in Chapters 3 and 4, decision making at farm level is a complex, dynamic and evolutionary process which;

> *"requires humans to perceive and evaluate problems relative to their personal experiences, level of internalised formal knowledge, cultural values, social constraints, current needs and stage in life relative to intergenerational pressures for transfer of wealth. These internalised variables comprise the framework for perceptual filters through which humans view the world and formulate solutions to problems"*(Stuth *et al.* 1993).

In order to make decisions with incomplete information and uncertainty the FD-MU develops some type of information routines and heuristic rules (Nelson and Winter 1982; Possas 1989; Andersen 1994) that are used as "natural[1]" decision support system [DSS]. Thus, each FD-MU has specific DSSs, which are built from specific experience and knowledge. The internal routines for information search appear to be maintained until some internal or external change forces the FD-MU to make changes. Apparently, this active "natural" DSS works on the basis of levels of "trust" and it was suggested in Chapters 3 and 4 that the FD-MU consists of the decision-

[1] Here "natural" is used to differentiate this from the artificial computer based decision support systems.

maker (usually the farmer) and the "trusted people" (usually the family). Therefore, the level of "trust" seems to be a key component in order to support decisions. People will accept advice and suggestions mainly from people ("trusted people") who, according to their perception, knowledge, traditions, beliefs, cultural and ethical values, social status and past experience, deserve their trust. The FD-MU appears to receive the support of "trusted people" that act as "experts" in different disciplines to provide the advice in these areas (e.g.: pasture, animal, economic and financial management).

The question that arises is how to provide more helpful and adequate knowledge and advice to a diverse population of farmers in order to support a process of sustainable development.

An increasing and wide amount of published and unpublished agricultural technical information, has been generated in Uruguay, but most of it is not readily available for use by the rural community at present. Also, the published information has usually been generated and stored in different institutions that have frequently followed different standards for data processing and therefore, it is difficult to establish comparisons among farms and develop cross studies (Anaya, Artigue and Ferreira 1983). As suggested in Chapter 3, most of the useful RPK is transmitted by word of mouth and is not stored or processed formally, so that its extended use is not available to other decision makers.

> " *Innovative and enhanced methods and techniques are required to make information and knowledge available to farm managers to support their production decisions utilising information from published and unpublished information sources and various "experts"*(Bentham 1994).

General considerations about DSS and the evolution of the concept will be described in this chapter, focusing on FSR/E and decision support at farm level. At the end of the chapter and in the light of information presented in the preceding Chapters, the main objectives and hypothesis of this work will be formulated.

5.2. Towards the link of "natural" and "artificial" Decisions Support Systems

5.2.1. General considerations

As presented in Chapter 4, livestock farming systems are complex, open, dynamic and evolving systems which involve human actions trying to control animals and the biological relationships of plants in order to satisfy their needs (Sørensen and Kristensen 1992; Dent, McGregor and Edward-Jones 1994). This complexity is partially explained by the interrelationship between farmer and family demands and biological processes and economic and financial considerations that are all constantly changing over time (Schultz 1939; Dent 1974; Gasson and Errington 1993; Gafsi and Brossier 1996). As presented in Chapter 4, each FD-MU had developed "natural" specific feed-back models of decision support: resulting from past experience, information and knowledge, and which are adapted according to new circumstances in order to solve problems, set objectives and monitor the production system (Le-Gal 1995). Previous experience, present formal and informal sources of information and the knowledge availability of the domain where the decision has to be made, appears to be the basic elements of the decision making process. In order to help these "natural" DSS, researchers have developed "artificial" DSS mainly based on quantitative formal scientific information available and the use of computer science. "Natural" and "artificial" DSS do not appear to have any obvious linkage between them. In consequence, "artificial" DSS have only been used by few FD-MUs and therefore the impact in development has been practically insignificant. Therefore, in order to analyse the possibilities for accommodating and linking these two different sources of information, a description of both "natural" (mainly based on informal and qualitative information) and "artificial" (mainly based on formal and quantitative information) DSS should be presented.

5.2.2. "Natural" decision support systems

In Chapter 4 the theory was presented to suggest that the FD-MU, as an integrated part of the farm system, and, based on a feed-back mechanism, will try to manage controllable factors such as inputs, labour and capital attempting to fulfil their overall objectives. The FD-MU controls the production system. However, the influence of uncontrollable and sometimes unpredictable factors, such as weather conditions, products and price variations, will require corrections to the decisions in order to maintain the initially planed objectives (Sørensen and Kristensen 1992).

FD-MU feed-back mechanisms

Therefore, in order to make decisions, control and monitor the production system, the FD-MU must to be informed about external conditions, (weather, markets, policies, available technology, etc.) internal production system conditions (technology and practices used in animal and pasture management; economic situation, etc.) and household conditions and requirements. The FD-MU continuously scans information from the external working environment, the farm production system, and the household.

This concept implies that the FD-MU is receiving information from the working environment, the production system and the household based on a cybernetic-type feed-back mechanism. When the results obtained deviate from the expected achievements, corrections may be introduced. This implies that the FD-MU bases decision making on feed-back mechanisms, gathering information about problems and developing possible ways to proceed in order to solve the problems (Mitchell 1978). These feed-back mechanisms allow the FD-MU to:

- adjust or set future objectives and goals through formal or informal procedures.

- measure system behaviour through results.

• monitor the system by comparing the results obtained with the anticipated objectives and goals.

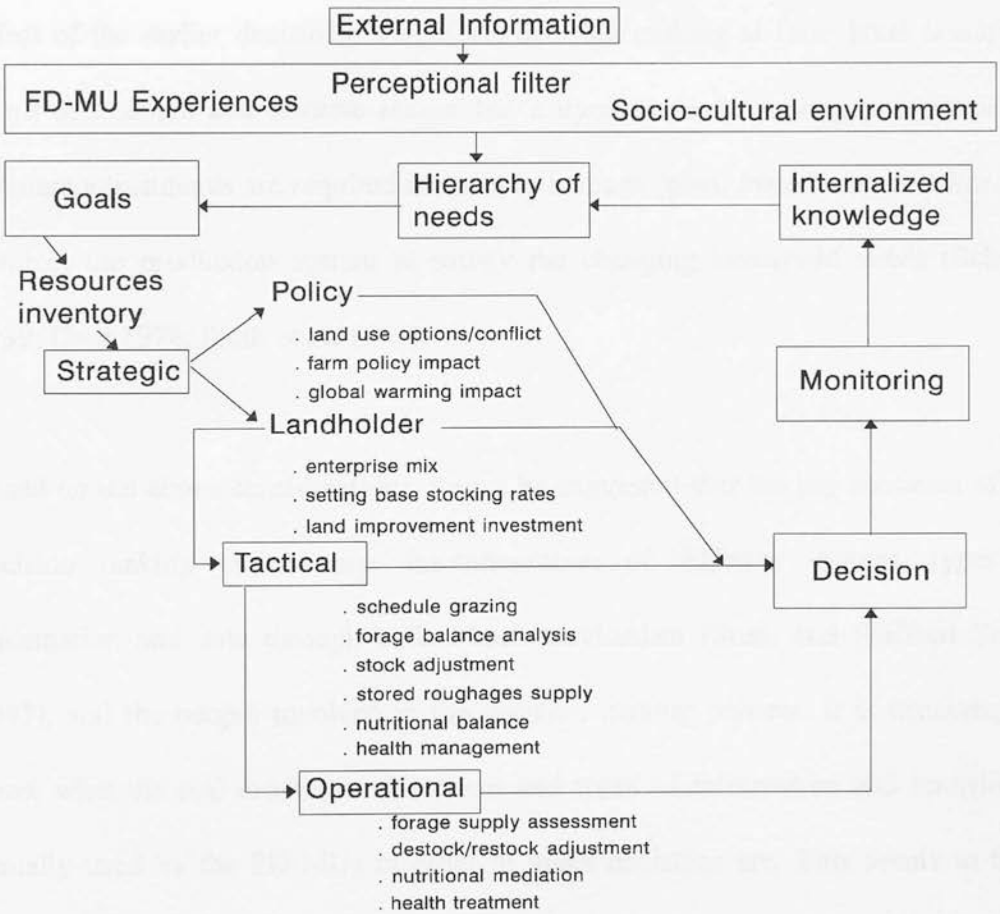
• decide an action implementing the necessary adjustments within the controllable factors.

This implies long term strategic objectives (structural system features, investment analysis, etc.), resource allocation and implementation of actions related to adjustments in controllable factors. The FD-MU needs to integrate information from different sources (soils, climate, pasture, animals, family, trusted people, economics and politics) which are dependent on scale in time and space (Stuth and Stafford Smith 1993). The management of an heterogeneous information environment would require information from different hierarchical levels and sources according to the planning horizons. Figure 5.1 attempts to illustrate the hierarchical structure and dynamic feed-back of the decision making process related to different planning horizons.

A strategic decision involves a planning horizon of years; a tactical decision implies actions for the approaching year and operational decisions represent within-year short-term adjustments in response to changing conditions (Stuth and Stafford Smith 1993).

As presented in Figure 5.1, strategic decisions are related to long term investments, enterprise mix and to how the current system could be affected by factors such as farm policies and land use options. Tactical decisions are of a more medium term nature and are related to pasture and animal management and control. The operational decisions are related to how to execute the task, for example health treatments for animals, nutritional mediation, etc.

Figure 5.1 Hierarchical structure of decision making and information feed-back



Source: Adapted from Stuth and Stafford Smith (1993) and Stuth *et al.* (1993)

Thus the decision maker will monitor the array of information from different sources which will often not be very precise (own observation, family "trusted people", "trusted people", advisers, extensionists, auctioneers, commercial and mass media, etc.) and, as a result of that, he may or may not introduce strategic changes.

It appears that a strategy is really a combination of tactical and operational decisions. Thus decision making is a never-ending process, where strategy evolves on the basis of decisions taken at lower hierarchical levels, in the sense that a strategy implies a series of decisions made over time where later decisions are taken in the light of the effect of the earlier decisions. Therefore, decision making at farm level is not the result of a single and discrete action, but a dynamic and evolving process where constant adjustments are required in order to manage (plan, implement, monitor and control) the production system to satisfy the changing household needs (Schultz 1939; Dent 1974; Stuth *et al.* 1993).

Based on the above considerations, it may be suggested that the key elements of the decision making process are: the integration of different sources, types of information and data through a feed-back mechanism (Stuth and Stafford Smith 1993), and the people involved in the decision making process. It is necessary to know what the real mechanisms, sources and types of information and knowledge actually used by the FD-MUs in order to make decisions are. This seems to be a basic step in order to understand how to help FD-MUs in making operational, tactical and strategic decisions. It can be suggested that the problem for research and extension is to determine what formal information, if necessary, might be added and should be transmitted through these active "natural" decision support systems in order to improve the decision making process at farm level (Dent 1994).

However, some authors suggest that only when the deviations between the results obtained and the expected achievement are substantially different, are major strategic changes introduced into the production system (Nelson and Winter 1982; Possas 1989; Andersen 1994). Hence, it appears that the essence of "natural" decision support systems is a question of dynamic feedback where information plays a key role (Dent 1994). So, in order to understand the decision making process, it is imperative that the main sources , types of information and routines for information search and analysis actually used by the FD-MU are recognised and identified.

Type of information used to support decisions

In order to characterise the actual DSS utilised by the FD-MU it is important to clarify what the main type of information used to support decisions for different groups of FD-MUs. In the present research two main types of information will be differentiated according to the source:

- formal information generated, processed and used according to a set of standard methods and rules and,

• informal information mainly generated by subjective ideas and/or implicit set of rules gathered as a result of observation of facts or verbal exchange of ideas.

It looks as though rural people develop observational skills in order to control, evaluate and monitor the production system based mostly on informal and qualitative information (Portela 1994).

It also seems that FD-MUs have some rules which support their decision making and control the production system and household (Soler 1990), such as observational rules for estimating pasture quality, grazing periods, resting periods, grazing system, animal production decisions, buying and selling animals, etc. Some FD-MUs estimate pasture quality by direct empirical observation of facts such as the amount of some species, colour of pasture and some indirect characteristics such as the increase in animal weight (INIA 1991). Other FD-MUs will support this subjective empirical perception with some objective sources such as weighing the animals with a scale, recording animals' weight and recording the gains by month and prices received, etc. (Estradé, Ferreira and Zaffaroni 1977).

Also, some FD-MUs will manage their animals according to "traditional" practices whilst some others will use latest technology based on the support of a specialist adviser or some technical articles. This means that FD-MUs, in order to control the household and the production system, have developed different search routines fed by various sources of information such as, formal records, technical meetings, papers, field days, etc. and informal sources (based on own observation and experience, verbal exchange of ideas with the family, friends, foreman, other FD-MUs, etc.). (Fergusson 1984). It appears that formal records and quantitative information are only used by a few FD-MUs and this mainly to support economic and financial decisions (INIA 1991). The use of farm records to support management decisions in Uruguay is mainly utilised by beef and sheep stud stock farms and large farms (Estradé, Ferreira and Zaffaroni 1977). Some other studies in Australia suggest that the majority of FD-MU do not base decisions on the analysis of farm records (Fergusson 1984; Frank 1995) but prefer to basing decisions on their previous experience, knowledge, "mental" analysis and intuition. As Alessi, Oberle and Mayhew (1994) point out, agricultural practitioners and extension agencies frequently base decisions on rules and easily calculated indices that help them perceive farm problems and their possible solutions.

The relevance of information as a resource

As presented in Chapter 4, five principal categories of information can be identified: those from research and extension agencies, those from commercial media, those from mass media, those from the markets, and those from the rural people's knowledge. It is important to recognise that in all the information sources presented, it is possible to find formal and informal information channels (Anaya, Artigue and Ferreira 1983). The type and source of information used by the FD-MU appears to be a relevant element to describe the decision support systems actually used by the FD-MU.

There is a great deal in the relevant literature about the key role of information in management decisions and it is considered as a productive resource that is potentially limiting and which influences the efficiency of production, marketing, processing and administration (Blackie and Dent 1979; McLeod 1990; McGrann 1991; Laudon, Traver and Laudon 1994). Information relevant to a problem reduces, even if to only to a small extent, the degree of uncertainty (Barnard 1979).

However, the FD-MUs will use the information sources that are relevant, reliable and useful to the process according to their perception of the problem and their knowledge, cultural and ethical values. Studies developed in Uruguay suggest that very few farmers keep and process production records. Informal sources of information and observation skills of farm practitioners appear to be the most common information resource to support farm management and market decisions (Estradé, Ferreira y Zaffaroni 1977; INIA 1991, 1992). However, it is necessary to determine what different strategies are developed by the different FD-MUs to obtain relevant information. Some FD-MUs may have accurate and complete information recording systems while others base their decisions mainly on "mentally" recorded past experience (Fergusson 1984).

Level of formal education and knowledge

There is a great deal in the relevant literature about the importance of the level of formal education and training in a process of change in rural development (Hayami and Ruttan 1985; Hofsteede 1990; Wignaraja *et al.* 1991). A great number of studies seek to prove that the level of formal education of the decision maker and his family is a very important factor in determining the attitude to changes and the adoption of new technology by the FD-MU (Sing and Ray 1980; Vijamakumer 1985; INIA 1991; 1992). The education level is considered important because the adoption of a new technique generated in a research institution usually implies changing to a new system where additional knowledge is likely to be required (Hildebrand 1986).

However, these studies have been concentrated mostly in the adoption of technology under a TOT approach, and therefore no attention was paid to the knowledge gained by the FD-MU in interacting with the working environment. Appears that some FD-MUs have adapting their practices based on a trial and error feed-back mechanism applied in response to changing conditions over long periods of time, that is rural peoples knowledge (Chambers, Pacey and Thrupp 1989; Haverkort and Zeew 1991; Scoones and Thompson 1994) and some others have adopting their practices mainly based on scientific knowledge or a mix of both types of knowledge

As presented "natural" and active decision support systems already in existence are diverse. Therefore, can be hypothesised that decision making at farm level mainly imply the use of thinking skills (using informal and/or formal information) selecting between different options (using intuition and/or analysis) and using judgement skills to competing alternatives mainly based on qualitative and perceptual information (rural people's knowledge and/or scientific knowledge) with reference to the problem under study in a whole farm socio-economic and cultural context (Dent, McGregor and Edward-Jones 1994).

5.2.3. The "Artificial" decision support systems

The "natural" decision support systems should continue to be developed and adapted by rural communities. However, there are complex agricultural problems where the decision making process could be assisted by the support of "artificial" decision support tools. The question of when and how to use and develop these "artificial" tools is an important issue to be analysed.

Agricultural researchers and extensionists have focused their attention in the development of "artificial" computer based models decision support systems such as linear programming and simulation models. Unfortunately, most of these models are: not friendly software, have high requirements of farm formerly recorded quantitative data, and are difficult to perform and understand for the majority of the FD-MU's population. Therefore, have been adopted only by a few number of FD-MUs (Zazueta 1991; Alessi, Oberle and Mayhew 1994; Edward-Jones and McGregor 1994). It appears to be clear that there is need for a new vision in order to develop more adequate and effective "artificial" decision support systems. However, it is important to present a brief description of the evolution and of the present situation of the "artificial" DSS.

Evolution of agricultural "artificial" DSS

Most of the efforts developed on DSS have been concentrated on computer-models based tools (Jones 1991). Designed to support and enhance but not to replace managerial decision-making, the benefits of such systems are often extremely difficult to measure; examples cited are improved communication between managers and an increase in the number of alternatives examined (Veryard 1991). The ultimate goal of all these decision aids is to try to improve decision-making, but they differ in their approach and in what they offer to the user (Plant and Stone 1991).

According to Heymann and Bloom (1988) the DSS concept was introduced into the literature by Scott Morton and Gerrity in 1971 while studying large organisations. The concept has been expanded and has been continuously evolving until the present. The idea emphasise on the analysis of key decisions (Mc Cosh and Scott Morton 1978). DSS can involve different identifiable methodologies such as traditional computer models based on operational research algorithms, simulation models, expert systems, geographic information systems, multimedia applications, participatory discussion groups, and structured thought processes (Stuth and Stafford Smith 1993; Plant and Stone 1991).

The aim of these systems is to assist managers in dealing with complex planning problems and in selecting appropriate technology. DSS systems in natural resources are similar to those in other enterprises in that they are designed for a specific problem area, incorporate specific planning horizons, and guide decision makers through a process of logical planning and technology selection (Stuth 1991).

Artificial tools to assist decision making in the agricultural sector has carried-out initially to support some specific areas as: beef quality (Chen and Robison 1988), beef-forage grazing systems (Thompson et al. 1992), forage management (Panciera, Bruce and Gavlak 1992), forage reserve (Rellier, Lardon, and Gibon 1990), pasture stocking rates (Swenson and Sedvic 1992), and range lands pest control (Berry, Kemp and Onsager 1992). These systems can imply the use of some computer programs such as, relational databases (Carlson and Russell 1988), geographical information systems (Pedersen 1994), systems simulations (Cardozo and Ferreira 1994), and economic and financial analysis (McGrann *et al.* 1990; 1992).

Some available DSS for grazing lands management

A review of the most used DSS available for ELPS can be found in the Proceedings of the 1991 International Conference on Decision Support Systems for Resources Management (Stuth and Lyons eds. 1991), and DSS for the Management of Grazing Lands (Stuth and Lyons eds. 1993). A brief list of the integrated applications based on the work of Stuth *et. al.* (1993) are presented:

Phygrow it is one of the products developed by the Ranch Systems Group, (**RSG** Texas A&M and USDA), attempts to be a general ecosystem model and calculate the available forage production for a site based on soil type, plants and weather characteristics for a particular location (Stuth, Conner and Hamilton 1997). Grazing Land Decision Support Application (**GLA**) is a software that includes, forage inventory, herd definition, feedstuff attributes, site descriptions, plant growth curves, forage balance, nutritional balance, grazing schedules, and economic analysis (Stuth, Conner and Hamilton 1997). **GrazPlan,** has been developed by CSIRO to support grazing in the high-rainfall Mediterranean environments of southern Australia. It is a whole farm simulation model and allows users to calculate pasture and supplement availability and expected production for different types of sheep and beef cattle (Moore, Donnelly and Freer 1991). **Rangepack** has also been developed by CSIRO, Australia. It is an integrated and modular DSS used to help farmers make strategic decisions, but considering also shorter-term tactical decisions in order to implement these strategies. Rangepack includes different modules: *HERD-ECON* that links herd dynamics with climatic and economic variability, *PADDOCK*, a GIS-oriented data base that contributes to paddock design for efficient grazing related to spatial matters, such as, water location in large paddocks and *CLIMATE,* a climate database that helps answer questions related to long-term investments in the arid zone of Australia, based on probability option concerned with drought management issues (Stafford Smith and Foran 1991). **Beefman**, is a range of computer programs that provides support in decisions related to the grazing of native pastures, sown pastures, and forage crops (Clewett *et al.* 1991). These programs have been developed by The

Department of Primary Industries of Queensland, Australia. Five DSS packages are included which are oriented to farmers and advisers (GrassMan, StockMan, BreedCow, DynaMan, RainMan and ForageMan) and three educational packages (BeefUp, FeedUp, and StockUp) that can be used to assist teaching about the consequences of stocking decisions, forage composition, and beef herd structure (Clewett *el al.* 1991; Ludwig, Clewett and Foran 1993). **Stockpol**, it is a whole integrated farm DSS that provides support on the optimum stocking rate, based on animal and pasture management practices (feeding, pasture growth and grazing, conservation and cropping). This DSS, has been developed in the Whatawhata Research Centre of New Zealand. The economic output includes financial reports based on gross margin and cash flow calculations (McCall, Marshall and Johns 1991).

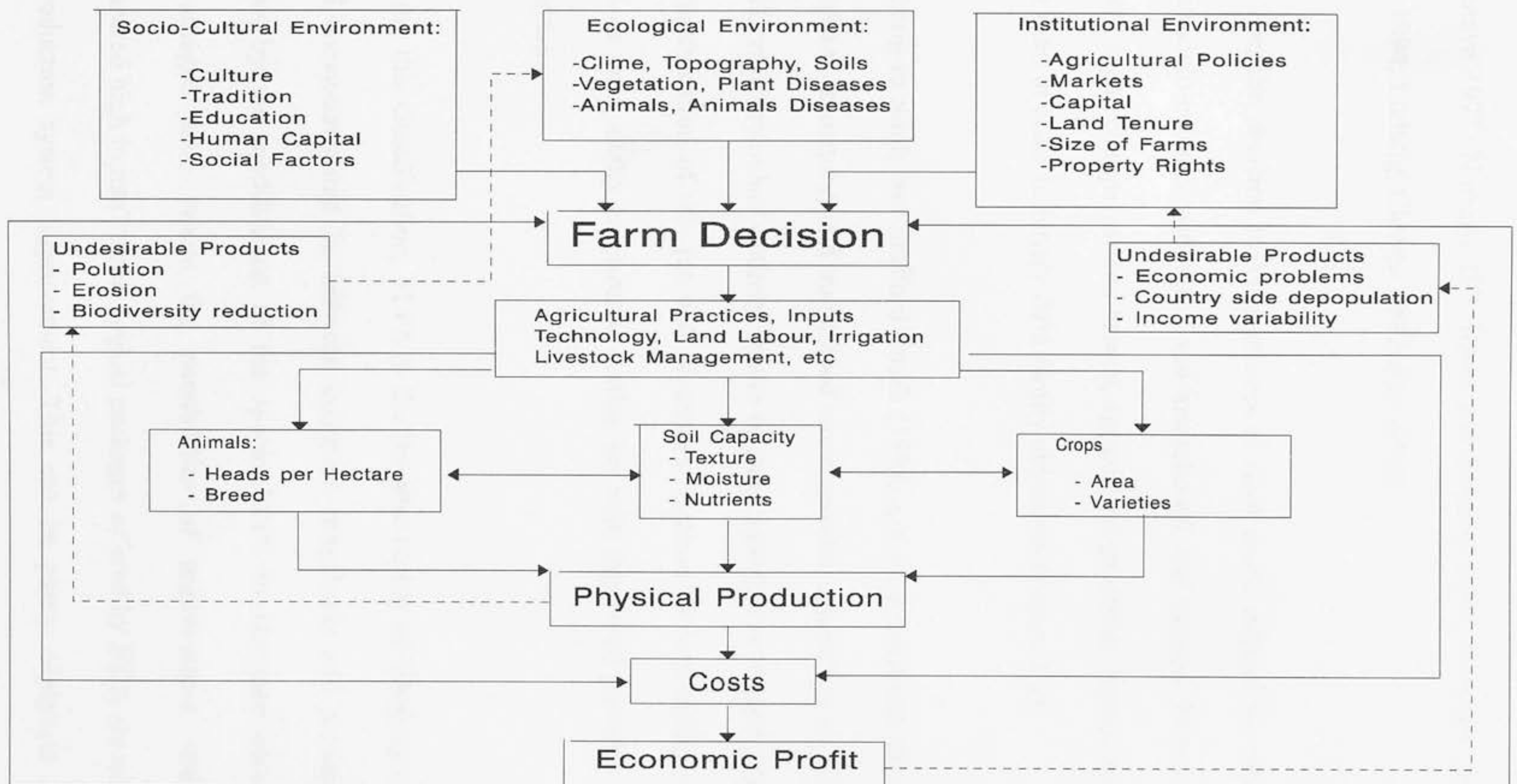
Despite the large amount of models developed in different areas, the impact of these "artificial" DSS at farm level is still negligible. The scientific contribution has been limited to the development of computer-base decision support systems of a formal nature, mainly based on experimental formal sources of information obtained from research stations and focused on providing solution to a single subsystem such as pasture production, beef production, economic and financial analysis or, at best, a group of related subsystems (Dent 1994). All these "artificial" decision support systems rely on a formal computer model and incorporate the bias of the experts that constructed the models about the best biological and technical data available (Cleaves 1988). That is the models are mostly based on formal scientific information and the urban view of the modelers without considering rural people's knowledge and sources and type of information actually used by the FD-MU. In order to monitoring the system the attention is place in a single enterprise such as yield or profitability rather than in the whole socio-economic and cultural context of the farm (Dent, McGregor and Edward-Jones 1994).

Most of the "artificial" DSS developed are highly commercial biased to high inputs type farms and have been applied only for few farms. Therefore, it can be suggested that the DSSs available in the market, do not fulfil the needs of the FD-MUs. This lack of understanding between "natural" and "artificial" DSS it is because rural people's knowledge have not been considered and the socio-economic and cultural conditions have been ignored.

5.2.4. Why Support decision making on Extensive Livestock Production Systems?

ELPS are open, dynamic and complex human production-oriented systems the objectives of which are mainly concentrated in developing practices and technological procedures to satisfy farmer and household needs by increasing the economic and ecological sustainability of the production process (Kok and Lacroix, 1993). The production process is highly dependent on variables of the working environment that are sources of risk and uncertainty which farmers cannot control (Figure 5.2).

Figure 5.2. Main components of the extensive livestock farming system



Source: Adapted from Diaz Bordenave

As presented in Figure 5.2, the complexity of these systems is the result of the interaction of biological, environmental and socio-economic processes (Díaz Bordenave 1977; Norman 197; Klein and Sonntag 1982; Sørensen and Kristensen 1992, 1994; Ludwig, Clewett and Foran 1993).

Therefore, the decision making process at farm level, depend on external factors, such as socio-cultural, ecological and institutional, and internal factors such as soils capacity, type of crops, animal breeds, agricultural practices, inputs, technology and labour used in order to satisfy farm family objectives (Figure 5.2).

According to Stuth and Stafford Smith (1993) grazed ecosystems can be classified into natural, transitory, and maintained environments, depending on whether animal production is dependent entirely on the original pasture (as in many rangelands) or on a modification of this (as with oversown legumes or in partially cleared forest lands), or on a totally engineered system (as with improved pastures and grazable croplands).

Applying this classification, ELPS in the Basaltic region of Uruguay correspond to grazed ecosystems that lie between complete rangelands and partially improved pastures by the modification of the species.ELPS in Uruguay occur mainly in disadvantaged areas where the possibilities of improvement with traditional "engineered high inputs" technological packages offered by INIA are not sustainable for production system improvement. This can be partly explained by the main characteristics of the basaltic region: high percentage of shallow soils, high drought risk, very low population density and a relatively poor infrastructure service.

The current technological package offered by INIA which is based on a high level of external inputs increases costs and the productivity in the short term, but does not ensure long term success nor does it represent a clear alternative for the long term. Orienting research and extension actions to support decisions based on short-term economic evaluations runs the risk being absolutely wrong over the longer term (Allen 1994).

It is precisely in relation to this disadvantage where DDSs tools can be useful to help in the analysis of different management strategies such as stocking rate control, sheep/beef ratio, breed, paddock rotation length, etc. Such management does not necessarily increase costs or external inputs and can produce a beneficial impact on the productive and economic sustainability of the system.

The complexity and dynamics of this kind of system justifies the need to develop tools to better understand the dynamics and the evolutionary interrelationships between agricultural policies, research, extension and farmers decision making. In this way, a clearer guidance at farm and policy levels may be provided.

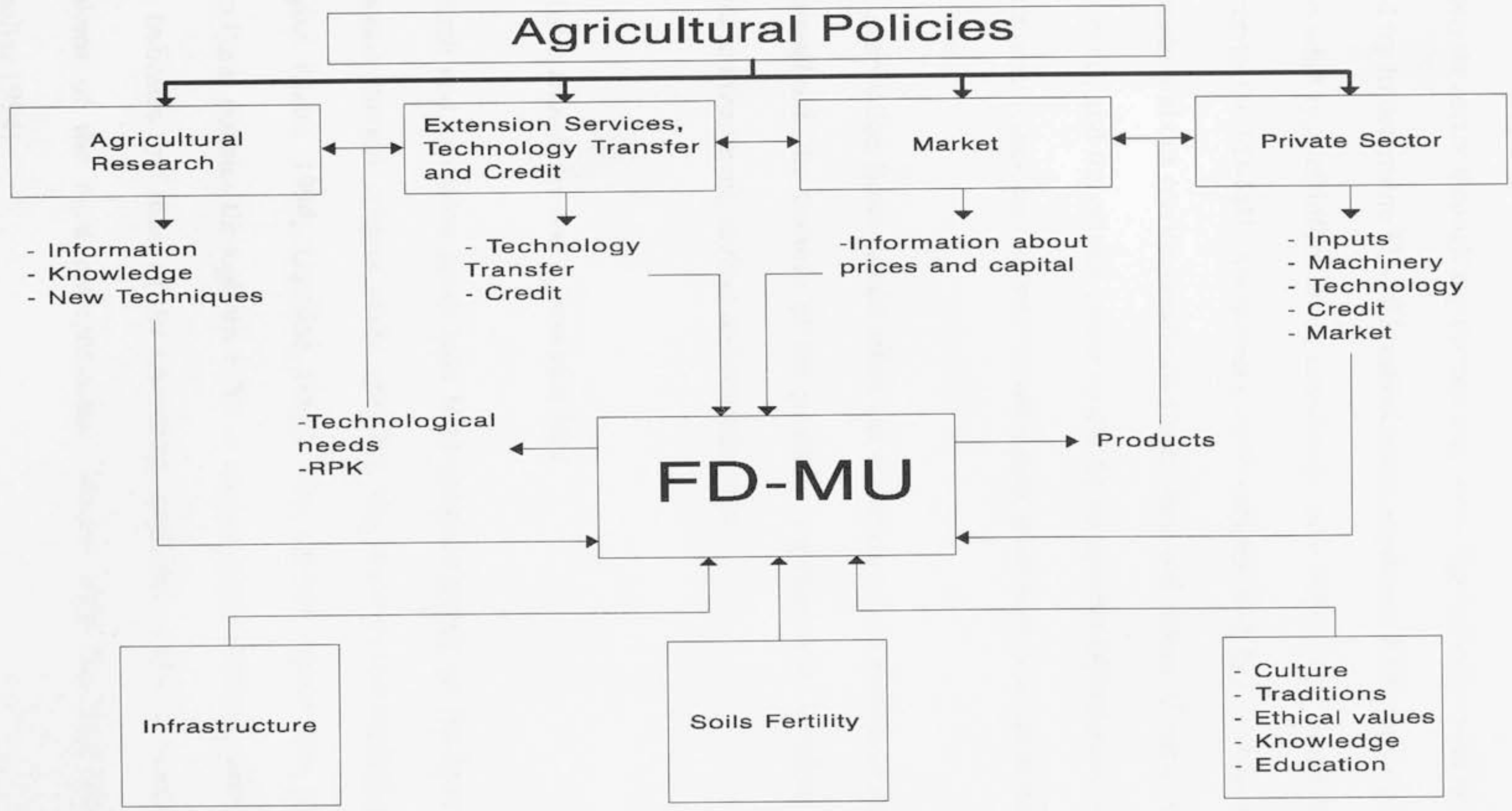
5.2.5. Information and knowledge transfer for decision making

Decisions hierarchy and ir.formation

A basic requirement to develop any kind of DSS is to establish the needs and availability of information. The needs and availability of information to make decisions in the agricultural sector varies according to the scale of the problem and the actors involved (Thorton 1994). Following Thornton (1994), “actors” are the participants in society, and they can be mainly suppliers or demanders of information at different scale. The availability, quantity and quality of information interchanged between different components such as, agricultural policies, research, extension, advisory work and farmers, is a key element to mobilise knowledge resources for problem solving and innovation (Röling 1989).

Figure 5.3 attempts to show some of the different institutional and internal factors and their formal and informal information flows. There is a set of institutions exchanging information and knowledge with the FD-MU. The services available and the informal and formal information channels -such as public or private extension, company advertisements, technology available, and mass media- have strong influence on FD-MU actions.

Figure 5.3. Institutional and internal factors affecting FD-MU decision making



Source: Adapted from Diaz Bordenave

As shown in Figure 5.3, agricultural policies provide the main guidelines to agricultural research, extension services, technology transfer, credit policy, market and private sector through regulations and laws. Agricultural research and extension would try to determine FD-MU technological needs and RPK availability in order to define what type of information, knowledge, new techniques, credit and technology to offer to the FD-MU. Auctioneers, rural officers, and mass media would provide information about market conditons (loan rates and prices of agricultural products and inputs), and the private sector would try to provide information (advertisments, private technicians, etc) in order to sell inputs, machinery, and technology.

This information flows would affect the evolution of the pattern of consumption of the household, the features of the production system and therefore the decisions related to investment, savings and consumption.

Available knowledge and information bias.

Research and extension funds have been assigned purely on the base of short term economic margin criteria while ignoring the socio-economic and environmental margins (Salas 1994; Uquillas 1994). The private sector has also influenced agricultural policies through the offer of capital inputs (Rölling, and Jiggins 1996). This indicates that most of the knowledge available is biased towards solving the problems of the most entrepreneurial farmers with the best natural resources (Uquillas 1994).

However, the importance of socio-economic and cultural elements including the dominant and local culture, traditions, language, knowledge and social factors have often been ignored (Chambers 1983; Dent 1994). There is no doubt that technological changes have had deep socio-economic impacts on agriculture (Astori 1979; Alonso and Pérez Arrarte 1981; Hildebrand 1986).This means that there is more knowledge on high input technologies propelled by the private sector industry, extension services and research centres. RPK which is the product of farmers' own experimenting, innovation and adaptation process is, in the main, verbally transmitted and not easily accessed to by other farmers. Empirical evidence shows that informal knowledge acquired by the farmer, the extensionist, the foreman, and the scientist by trial an error overtime is used to assist decisions. These sources of "rural people's knowledge" and "rules of thumb" are relevant to the analysis of decision making.

The question is how to transfer the knowledge. It is necessary to identify the problems and the useful knowledge and understand better the inner mechanisms of the "natural" DSS actually used by the FD-MUs. To develop research and extension programs relevant to farmers problems and needs, research needs to take, as starting point, the specific socio-economic and agroclimatic conditions of different groups of farmers (Heinemann and Biggs 1985).

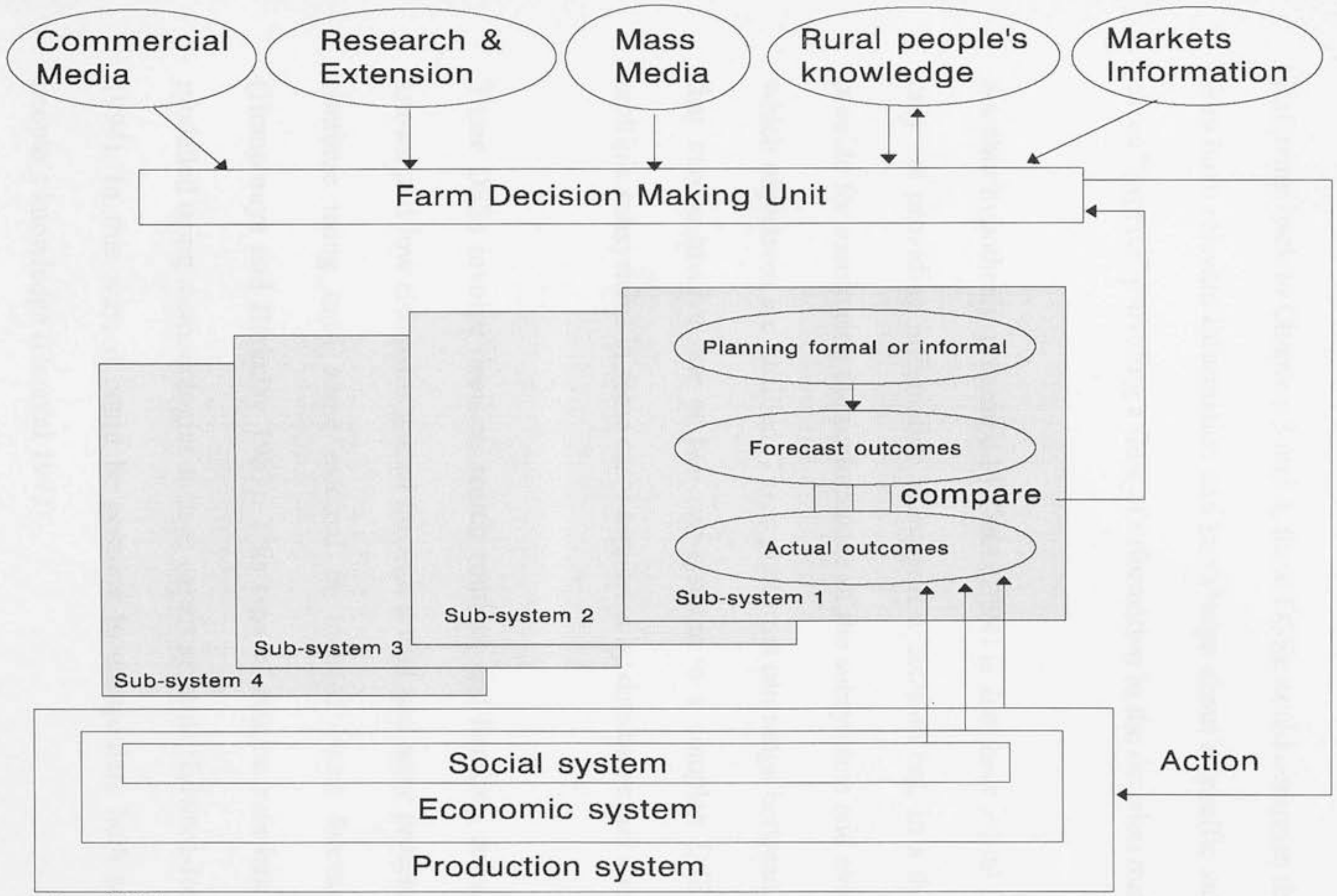
5.3. Understanding the farm decision making unit decision support

In order to analyse the decision making process at farm level, Röling (1994), distinguished the "platform" of decision making on one side and the actual system on the other. At farm level, the platform may be illustrated by a group of people linked by interdependent relationships (marriage, kinship, affinity, partnership, convenience, advice, trust, dependency, etc.) that makes decisions on the use of the natural resource ecosystem (farm) in order to solve their common problems and achieve their common aims.

The "platforms" of decision making at farm and communal levels have a key role in identifying research problems, research prioritisation and transferable knowledge (Dent 1994).

Dent (1994) has hypothesised that the "platforms" that operate at farm level can be assimilated to a nested group of active DSS actually used by farmers in order to make decisions. Figure 5.4 attempts to illustrate this view. This suggests that the FD-MU support their decisions on the basis of a set of specific subsystems of decision support that provide information related to specific areas such as: animal production, pasture production, crop production, economic and financial and, therefore, information is perceived by the decision maker as associated to a different sub set of information search routines. As presented in Figure 5.4, each subsystem provides information to the FD-MU which will be evaluated taking into account the

Figure 5.4. Decision Support System Structure of the Farm Decision Making Unit



Source: Dent (1994)

information messages received from the commercial media, research and extension, mass media, rural people's knowledge and markets information. As a result an action is taken that will affect the production, social and economic system and the new information to use in future decisions.

Referring back to Chapters 3 and 4, these DSSs, could comprise the "trusted people" who have relevant information and knowledge about a specific subsystem, and who act as "experts" providing a flow of information to the decision making unit.

Another hypothesis presented by Dent (1994) is that these actual DS subsystems not only act providing information to support a decision but, in a dynamic sense, also provide for monitoring the performance of the subsystems and evaluate the extent to which objectives are fulfilled. These platforms can range between very simple DSS, that maybe involve one or two sub-systems to a complex DSS that can involve multiple subsystems in some cases supported by data bases and computer models.

These DSSs involve decision search routines and heuristic rules, that follow well known and low risk paths gained through a trial and error process that farmers will continue using until some external or internal event forces them to change (Humphreys and Berkeley 1983). This type of routine rule based process can be modelled using methodologies such as expert systems (Edward-Jones and McGregor 1994). In this way, it could be possible to encapsulate both scientific and rural people's knowledge (Genotal 1992).

5.4. Objectives and hypothesis

In the light of the information analysed, the following objectives and hypothesis are formulated:

5.4.1. Objectives

1. To understand better the decision making process of extensive livestock farmers.

2. To develop decision concepts for research and extension agencies and policy makers.

3. To demonstrate that rural people's knowledge plays an important role in development.

5.4.2. Hypotheses and sub-hypotheses

1. It is possible to understand better the decision-making process of extensive livestock farmers of the basaltic soils of Uruguay.

    1.1. There is an implicit decision support system on all farms mainly developed by family experience (grandfather, father, mother , etc.), household, kinship, social interrelationships, own experience and rural people's knowledge.

1.2. There is an information system built within the framework of the farmer decision support system and rural people's knowledge where informal information is the main source of information in order to support and make decisions.

2. It is possible to identify FD-MUs behavioural Types of FD-MUs and depict "models" of the "natural" decision support system structure in farmer decision-making.

2.1. It is possible to identify and classify groups of farmers by features in the decision making process in order to target better the research and extension complex to bring about change.

2.2. Farmers do not modify the existing farm system until forced by some change.

3. Using such "models" it is possible to define more appropriate recommendation domains for research and extension activities.

3.1. INIA is less efficient than it could be in satisfying and targeting farmers' needs.

5.5. Summary of consideration

This Chapter had been devoted to review the possibilities of linking "natural" with "artificial" decision support systems. The Chapter claims that in order to develop effective "artificial" tools to support decisions, it is first necessary to understand how the "natural" DSS works

Section 5.2.2 provides a description of how the "natural" decision support system can be conceived, the main functions, information sources and knowledge actually used to make decisions. The literature review suggests that in order to make strategic, tactical and operational decisions, different types and sources of information need to be analysed by the FD-MU. It has been suggested that one of the key elements in decision making is the need to integrate different sources, types of information, knowledge and data into a feed-back mechanism to try to control the farm family system.

It was also mentioned that this "natural" decision support systems already in existence are the product of FD-MU's diverse experience and could mainly imply the use of thinking skills to select among different options.

A brief review of the evolution and main characteristics of the "artificial" decision support systems was also presented in order to show the main features of these systems. It was also described that the aim of these "artificial" systems is to provide support assisting decision makers in dealing with complex planning problems and in selecting appropriate technology. Despite the fact that there is a large amount of models that have been developed to provide support to the farm decision making process, they are seldom used by some farmers and therefore the impact of these "artificial" DSS at farm level is still nearly insignificant. It was also pointed out that this could be explained by the fact that "artificial" DSS models are highly commercially biased and rely on formal sources of information and the urban view of the modelers ignoring rural people's knowledge. Therefore, the "artificial" DSS analysed does not fulfill the needs of the FD-MUs (Section 5.2.3).

It was also pointed out that ELPS are open, dynamic and complex systems that involve the interaction of i) external factors such as the socio-cultural, ecological, and institutional, and ii) internal factors such as soil capacity, topography, etc. Therefore, the complexity and dynamics of this type of system justifies the development of tools that can support the decision making process (Section 5.2.4).

The literature review allows to suggest that there is an enormous amount of information in the agricultural sector not fully used and which could be useful for decision support on farms. The information and knowledge available are biased to the urban view of agricultural problems whilst RPK was almost ignored. Most of this information and knowledge is informal, not supported in any traditional for like reports, books, texts or files. Among this information there are "rules of thumb" used by rural people that are kept in mind and form collective experience (Section 5.2.5).

The important issue is that only by having a better understanding of the "natural" DSS it may be possible to develop some useful and efficient "artificial" decision support "models". Modelling, such as in decision support systems and expert systems, may be useful to encapsulate both scientific and RPK qualitative knowledge and rules. In this way, modelling efforts should not necessarily be constrained to current knowledge levels. All direct or indirect participants in the process of decision support system development must be able to grow as their own knowledge base increases.

This process implies the search for "good rules of thumbs" and rural people's knowledge relevant to different groups of farmers, and putting them in a formal way to make them available to other farmers or extensionists. Farmers' participation in this process is crucial. Knowledge is enhanced and becomes internalised by using modelling and DSS and by the learning of the agricultural system (Stuth and Stafford Smith 1993).

Based on the literature review of Chapters 2, 3, 4 and 5, the research objectives and hypothesis were developed (Section 5.4).

Chapter 6

Methodology

6.1. Introduction

This chapter presents an outline of the methods and procedures used to obtain the information relevant to test the hypothesis developed in chapter five. The information will also be used to better understand the decision making process at farm level. The perspective used here is based on a system approach which includes the FD-MUs as the unit of analysis (Osty 1987, 1994; Dent 1994; Gafsi and Brossier 1996). Special emphasis in this chapter is on the survey methodology and results. The cluster analysis, case study and conceptual models developed will be described in Chapters seven, eight and nine.

Extensive livestock production systems [ELPS] in the basaltic area have been characterised for presenting low production and low intensity use of farm resources (Astori 1979; Alonso and Pérez Arrarte 1981; INIA 1991). The essential problem for decision makers in mixed cattle and sheep systems is the allocation of resources among alternative activities to achieve a high level of satisfaction. Winter feeding is one of the main bottlenecks for the development of the area. The level of adoption of the different technologies for winter feed management in the ELPS is relatively low compared to other production systems despite efforts on research and extension done by INIA and other development agencies.

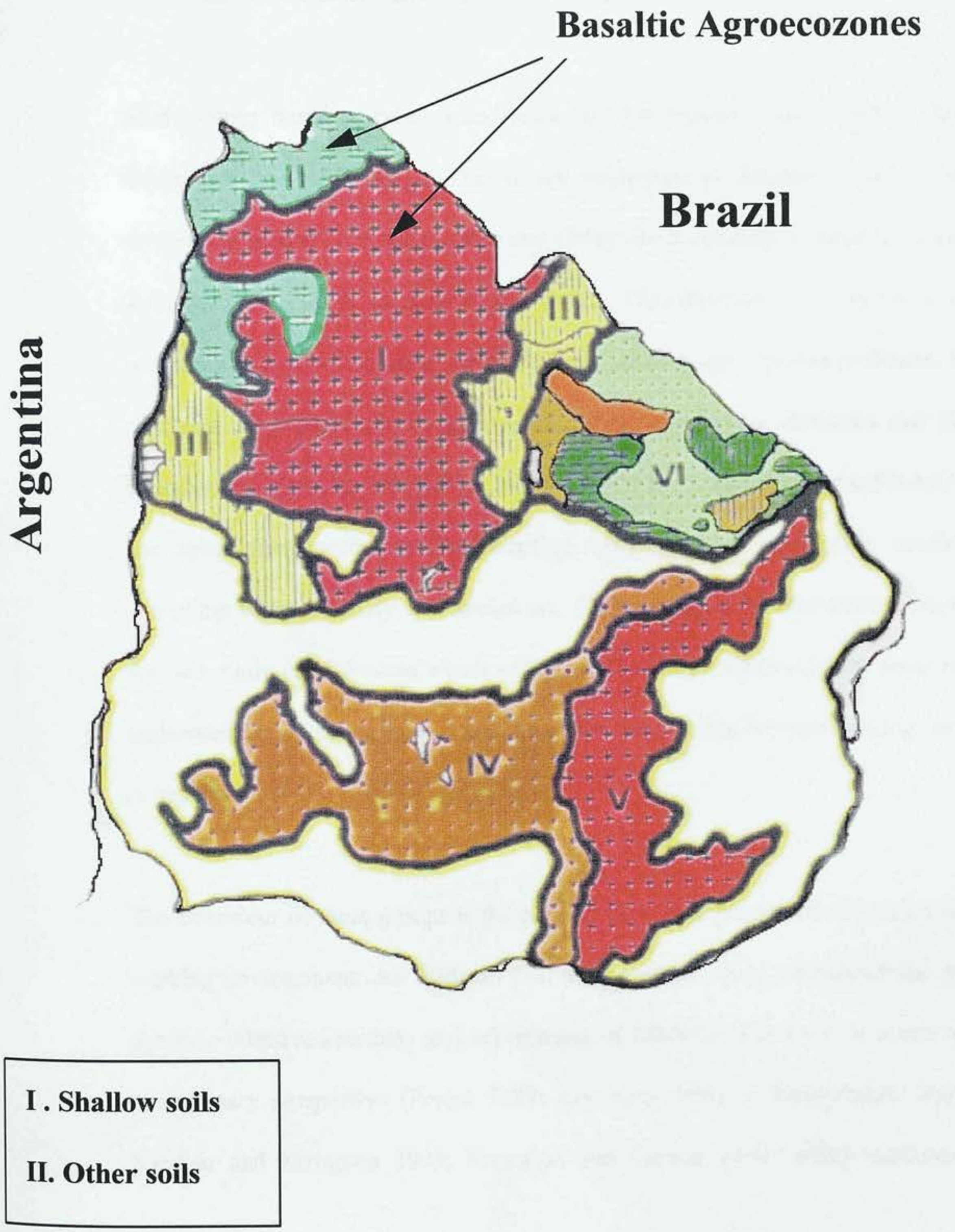
In order to find an explanation for the main considerations underlining the low level of adoption on the ELPS, INIA committed Equipos Consultores Asociados [Equipos] to carry out an exploratory study. Its main objectives were to determine and analyse technological demands, aims, attitudes and behaviour of ELPS farmers (INIA 1991; 1992). The study involved a survey of the whole area of ELPS. The main agroecozones associated with ELPS are presented in Figure 6.1.

Despite the valuable information obtained through this study, the surveys were exploratory, and focused the analysis on production considerations which the farmer had as an individual. Traditionally, studies on farmers' decision making were based almost exclusively on economic, technical and managerial decisions without considering the relationships that these farmers had with their families, other "trusted people" and their communities (Uruguay MGAP-DIEA 1974; McGrann *et al* .1991; Grau and Paolino 1995). Is very important to identify the mechanisms and people involved in key decisions at farm level in order to develop rural support policy for farmers. (Dent 1994; Dasgupta 1995). The objective of this work is to understand more deeply all the elements behind the decision making process of the farmer.

The current research will focus on the analysis of the ELPS on basaltic soils. The main reasons for choosing the basaltic region are:

- INIA's interest at national level to better understand ELPS in order to target future research.

Figure 6.1. Main Livestock Agroecozones



• To explore whether or not the quality of resources can affect the functioning of FD-MUs under relatively similar technology offers and pressure to change their farming practices, given that there is a clear differentiation between shallow and other basaltic soils' suitability .

Methodology based on primary and secondary information is developed to classify farms into types of FD-MUs. This allows researchers to describe recommendation domains (Perrin *et al.* cited by Williams 1994) which can help in targeting research and extension efforts to their special needs. Classification of FD-MUs is done according to their evolutionary ability to cope and manage complex problems. Such as means socio-economic conditions, strategies, information networks and flows, attitudes, decision support systems, rules and routines used to adapt the FD-MU and the production system to the working environment's changeable conditions prevailing when the study was carried out. This provides a suitable static framework for case study identification which will provide detailed information to assist in the understanding of the dynamics and inner elements of the decision making process (Chapter 8).

The behaviour of these groups is the product of a slow process of adaptation to the working environment. An in-depth case study allows us to understand the micro dynamic adaptive reactions and adjustments of FD-MUs. The study is based on an evolutionary perspective (Possas 1989; Andersen 1994) of Farm-Family Systems (Gasson and Errington 1993; Errington and Gasson 1994) which explores the changes and pressures within and without the FD-MU. Through the identification of the main rules, heuristic routines and information flows used by the different types of farmers, real decision support systems can be modelled.

6.2. Outline of the Methodology

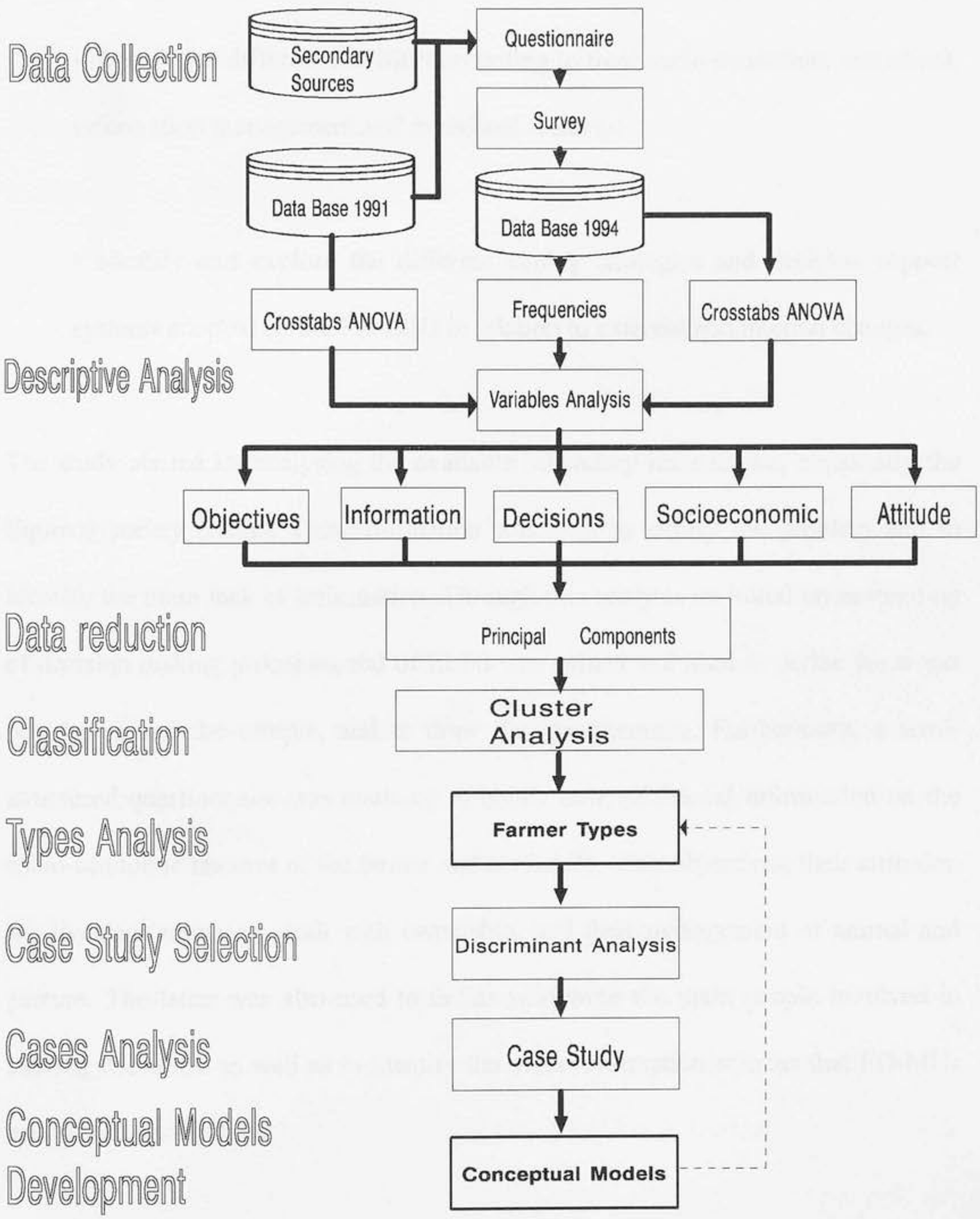
This methodology covers how to gather, store and organise information about farmers working on basaltic soils in Uruguay. The sequential procedure is presented in Figure 6.2.

The strategy applied involves the combination of different data collection techniques, and aims at providing information about the different components that affect the patterns of FD-MUs' decision making process.

The methodology combines the application of empirical analysis based on quantitative research methods (statistical methods) with in-depth studies based on qualitative research methods (case study).

It is now widely recognised that all farmers do not react in the same way when faced with technological changes (Guerin and Guerin 1994; Williams 1994; Hildebrand 1986; Chambers 1983; Binswagner 1980; Dillon and Sacandizzo 1978).

Figure 6.2. Methodology showing the different steps taken



It is therefore necessary to:

• classify the different FD-MUs according to their socio-economic, attitudinal, information management and decisional features;

• identify and explore the different coping strategies and decision support systems adopted by the FD-MUs in relation to external and internal changes.

The study started by analysing the available secondary information, essentially the Equipos survey results. This information was used to clarify the problem and to identify the main lack of information. Through this analysis an initial understanding of decision making processes and of ELPS was gained and used to define the target population and the sample, and to draw the questionnaire. Furthermore, a semi-structured questionnaire was made up to obtain new, additional information on the socio-economic features of the farmer and his family, their objectives, their attitudes, the livestock numbers, dealt with ownership, and their management of animal and pasture. The latter was also used to define who were the main people involved in making decisions, as well as to identify the main information sources that FD-MUs use to manage the farm.

The technique of Principal Components was applied in exploring the relevance of all the available variables. The original variables were thus reduced to a few factors which would explain an important percentage of the total variance in the population under study. With these selected factors a FD-MUs classification was done through cluster analysis. The clusters allow the combined information about farmer objectives, family socio-economic features, people involved in decision making, information flows and attitudinal factors, physical characteristics, farm types and FD-MUs of the production systems to construct a typology of FD-MUs.

The survey provides static information about the FD-MUs, which is not enough for an in-depth understanding of the decision making process. Case study methodology was chosen in order to study the dynamics of the decision making process. This method has been used mainly in farm management research to deal with indistinct problems of a complex nature such as the main features of decision making, how decisions are made, what the decision criterion is and when to act and when to do nothing (Howard and MacMillan 1991). Based on the cluster, the discriminant analysis output and the subjective data from the survey, three representative farmers were selected. The objective is not to represent the average farmer behaviour, but to identify FD-MUs such as those that, while clearly belonging to one of the groups have also developed a strategy for adaptating to the working environment which has permitted them to grow. In this way, information flows, decision support systems, sets of heuristic routines or conventions and mechanisms of control used by the FD-MU in order to manage the complex Farm-Family System interacting with the working environment were explored. A series of non structured interviews were recorded and checked with the case farmers. In each case, the decision support systems and rules used actively by the FD-MU were also analysed.

Based on the analysis and the understanding gained through the study, conceptual models of FD-MU's for each group of FD-MUs were developed and identified (Chapter 7 and 8). These conceptual models represent the micro dynamics of the decision process, the behaviour of each group, the people involved and associated with the FD-MU, the real information flows, and the established rules.

6.3. Procedures for Survey Development

The survey includes the definition of the population, sample design, variables' selection, questionnaire definition, interviews for data collection and the development of a data base for subsequent analysis of the information through statistical packages in accordance with the work's objectives.

6.3.1. Information sources

Secondary Sources

The main information sources considered in this study are DICOSE, soils map and INIA-Equipos' survey.

DICOSE (National Office for Livestock Control)

All agricultural farmers who take part in the marketing process of bovine cattle, sheep or wool or who have more than 10 bovines or more than 50 sheep are asked to supply DICOSE[1]. information with on an annual base This information is gathered by the police in their districts and compiled by DICOSE at national level. DICOSE provides information stratified into size of farms the use of the land, the number of farmers, beef, sheep and horses.

INIA Equipos survey

It was convenient to base the study on Equipo's work already accomplished in 1991 for the basaltic agroecozone. With this background, it was possible to focus the current questionnaire on more specific aspects of the decision making process, considering the farmer, his family and the environment of the decision making unit as a unit for analysis. In this way, it was possible to make of the information gathered in the previous survey along side data from the new survey.

Target population

The target population of this survey was drawn from 1090 farms larger than 200 hectares and located in the basaltic region of Uruguay (Table 6.1). It comprises farms located on shallow and deep basaltic soils, dedicated mainly to extensive pastoral use, based on mixed grazing of cattle and sheep (Appendix 6.A and 6.B).

[1]DICOSE is the organisation created in Uruguay in 1974 with the assignment of getting real knowledge about: movement, stocks, quantities and volumes of slaughter of bovine cattle and sheep, and wool and leather stocks throughout the national territory. Also, control on stocks, movements in agricultural market (particularly that of wheat, flour, rice and sorghum).

Table 6.1. Total number of farms in the agroecozones and farm sizes in the basaltic region

Size	200 to 999	1000 to 2499	+ 2500	Total
Agroecozone I. (Shallow soils)	507	157	62	726
Agroecozone II. (Other soils)	264	73	27	364
Total	771	230	89	1090

Source: DICOSE 1991, INIA 1991

Farmer sample

The sample was defined using Equipos' survey (1991) and DICOSE's information (1991) for the farmers' affidavit declaration certificate 1990 / 91. In order to assure the complete compatibility of the data, the sample was taken at random from the 202 farms of Equipos' sample. Therefore, the information and main assumptions developed by Equipos were incorporated to the sample design. The Equipos survey only considered farms larger than 200 hectares based on the assumption that the study was to focus on commercial farms[2].

Sample size

The sample's size for each stratum was chosen according to the variance in size of the farm, the percentage of farms in each stratum, and with 90 percent minimum confidence of and 15 percent error (Table 6.2). The number of farms in the sample also had to be compatible with the survey resources available.

[2]The population of farms between 200 to 999 hectares is a small commercial economic unit, considering that the net income hectare commonly achieved by these ELPS is of about 5 pounds a year.

The criterion used took into account the heterogeneity concerning the quality of the land for cattle and sheep and the fact that these differences in quality would affect the features of the farm, as well as the FD-MUs attitude towards technical change and behaviour.

A random sample of 81 farms devoted almost exclusively to extensive pastoral use was drawn from the 202 Equipos' farms. The sample was arranged by size (3 size groups) by agroecozone (2 zones) and by strata (Table 6.2). A detailed explanation about the sample design criteria is presented in the Appendix 6.B.

Table 6.2. Sample size definition

Stratum		DICOSE Nij[3]	EQUIPOS $N'ij$[4]	Mean x	Variance Var	Z	Error e = 0.15	n[5]	Done
I	Agroecozone I	507	40	512	49448	1.64	76.8	14	14
II	Agroecozone I	157	30	1524	171409	1.64	228.6	7	14
III	Agroecozone I	62	35	3879	2610462	1.64	581.85	13	14
IV	Agroecozone II	264	40	513	56072	1.64	76.95	16	17
V	Agroecozone II	73	30	1481	135364	1.64	222.15	6	9
VI	Agroecozone II	27	27	3983	3657173	1.64	597.45	13	13
Total		1090	202					68	81

The sample size determined on the basis of a stratified random sample is presented in the column **n**. Also is presented the minimum number of cases to be developed in each stratum in order to have a 90 percent confidence. As a way to increase

[3] N_{ij} original size of the stratum in DICOSE population.
[4] N'_{ij} size of the stratum in EQUIPOS sample
[5] Minimum number of farmers to be interviewed by stratum to have 90 percent confidence.

variability, the size of the sample was increased from 68 to 81 farmers, specially in stratums' II and V, where the number of cases was the lowest. Can be argued that by this way the number of cases to be developed in each stratum would affect the results related with size of the farm and agroecozone. However, the interest in this study is to develop a sample in order to elaborate an statistical analysis which involves multiple variables. In order to enable a multivariate analysis the number of cases in stratums II and IV was increased.

Productive Specialisation

Specialisation categories defined in beef production are: Seed stock farms, Finishers, Complete Cycle, Cow-calf. Two production systems were considered for sheep: Complete cycle and Ewe-lamb. Seed stock farms produce bulls, cows, rams and ewes of breeds such as Hereford, Aberdeen Angus, Corriedale, Merino, etc. Finishers buy young animals and feed them during the last stage of fattening. In complete cycle systems, all male calves are raised until they can be sold fat for slaughter. Cow-calf production systems raise the animals during the first stage of growth and sell the calves and bullocks to the finishers at sale prices.

Selection of sample sites

The sample sites correspond to administrative divisions called "policy sections" (districts). The criteria used for selecting the sample sites was that of having more than 70 percent of the area of the site fall into the agroecozones analysed:

• Agroecozone I consists mainly of pastoral lands conformed predominantly of superficial (15 to 20 cm) red and black soils of medium to high fertility, that have high risk of drought. In the red soils prevail low productive and low quality native pasture, while in the black soils the native pasture is somewhat more productive and of better quality (Berreta 1994). The sites chosen are presented in Figure 6.4 in green and described in Appendix 6.A. and 6.B.

• Agroecozone II, consists mainly of agro-pastoral lands developed on medium and deep soils of the basaltic region. The depth may vary between 40 and 5O cm; there is small risk of drought, and a greater quantity of forage. These soils have a high potential for improvement (Berretta 1994). The sites chosen are presented in Figure 6.4 in yellow and described in Appendix 6.A. and 6.B.

The land quality map (Figure 6.3) was superposed overlapping the administrative police district map (Figure 6.4) in order to locate civil administration data within the agroecozones.

Questionnaire bias

There are some factors in the working environment that could be a source of bias:

1. During the survey, prices on the main products were particularly low. The forecast on wool and sheep prices was that they should continue stagnant or to decline which could have affected the decisions about the number of sheep to maintain in stock.

Figure 6.3. Shallow and other basaltic soils

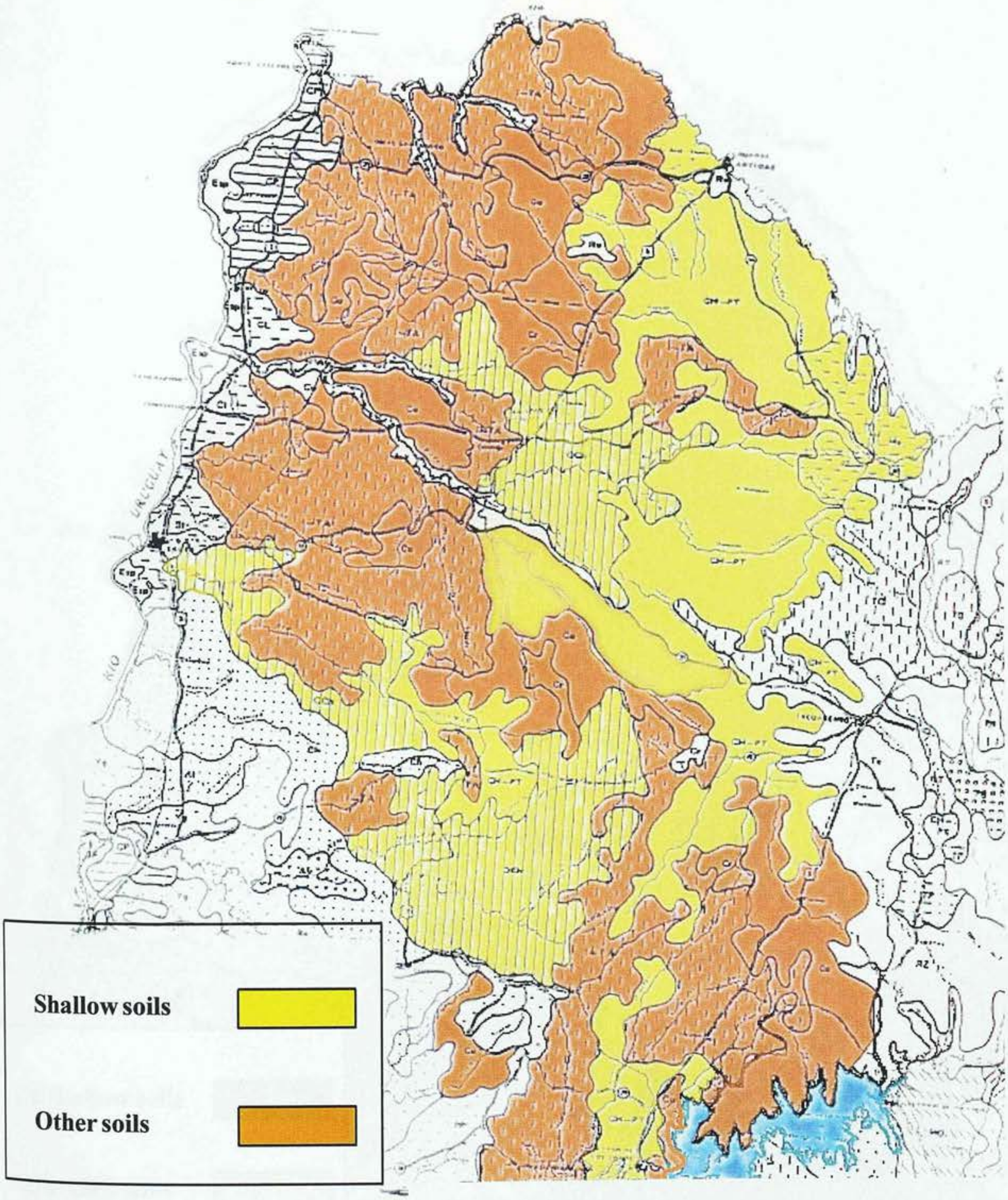
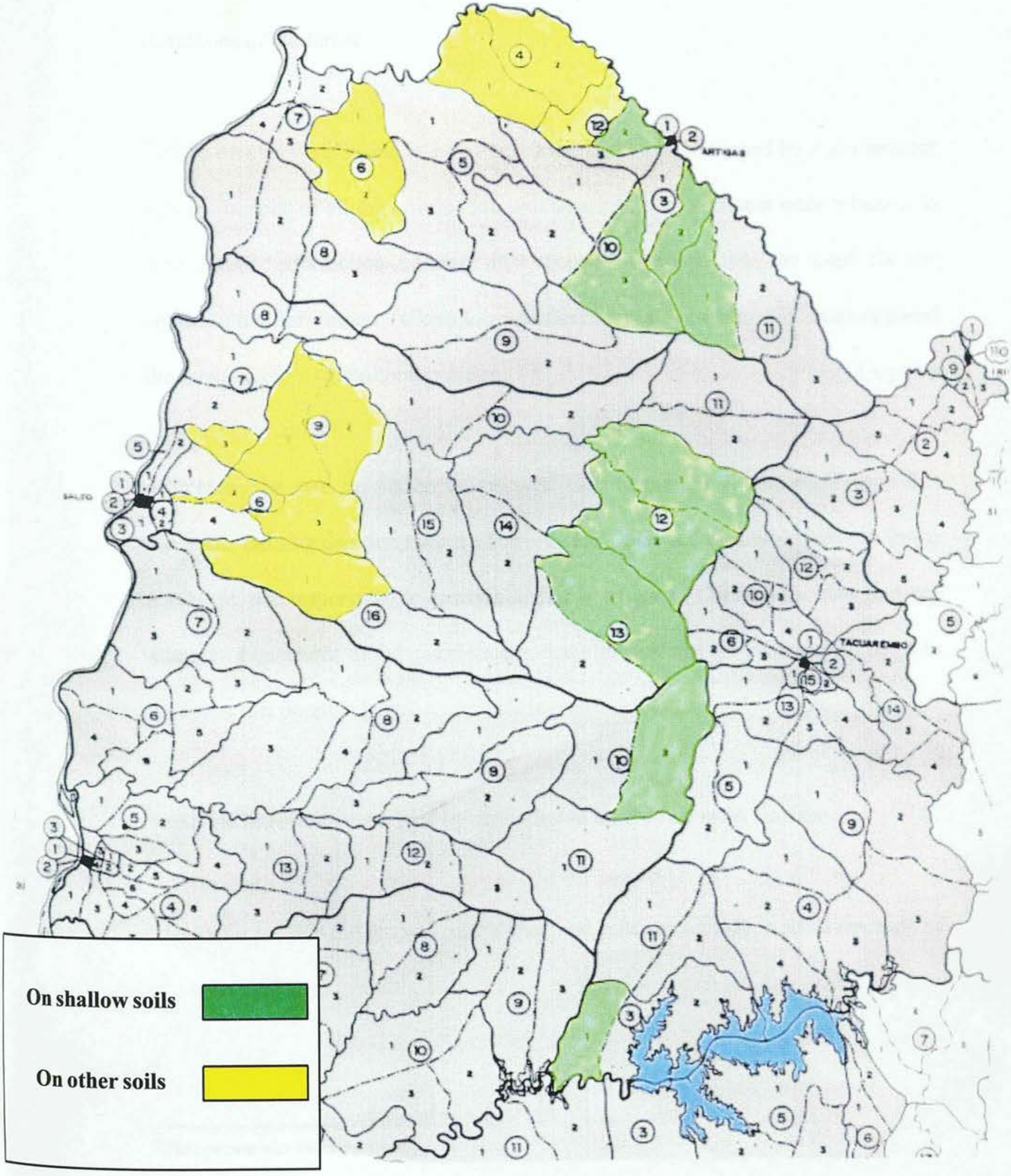


Figure 6.4. Sites for inquiry, police sections and census sectors



2. The socio-economic and biological effects of the drought (Uruguay MGAP 1991) of 1989, were still affecting some of the farm-family systems' decisions. The drought had direct effects on the stock and therefore on the economic and financial conditions of the farms.

3. Interviewers were suspicious that the survey had been developed by a government agency. In spite of all the information was acquired, some farmers were reluctant to give certain information because they thought it would later be used for the application of new taxes. Talking to respondents revealed that most of them opposed the government's agricultural policies.

4. In every the case, the person interviewed[6] was the individual who was responsible for major farming decision making. Nevertheless, there are natural differences in the ability of the respondent to provide accurate answers. The sample size and the number of questions in the questionnaire that allow checks for consistency, helps to minimise this possible bias.

5. All the interviews were held by the author alone for two main reasons:

- To provide the farmers with a clear and consistent message about the aims of the study.

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[6] This person was self identified.

• To have the opportunity to interact with and gain knowledge from the entire sample of farmers. In this way was possible to have a better understanding of the diversity of FD-MUs in their working environment.

It was supposed that with the sample size and the large number of questions these bias can be statistically controlled[7].

Questionnaire design

In order to elicit useful information from the farmer population, a semi-structured questionnaire was chosen. Based on the study of the Equipos questionnaire form, it was possible to develop a new questionnaire focused on the most relevant additional information which permits the issue of farming decision making process at farm level being addressed. A draft questionnaire was distributed to the research staff who work in INIA-Tacuarembo, as well as to some social scientists who have experience in questionnaire development. Several suggestions were made by them and were introduced in order to improve the questionnaire. After three improved questionnaire forms, the detected inadequacies or irregularities were corrected and a pilot study (Bhattacharyya and Johnson 1977) was carried out.

The pilot study was carried out with 6 farmers near Tacuarembó, in order to test the clarity of the questions and to estimate the difficulties in some of the replies answers.

[7] The size of the sample, statistically determined and the large number of questions in the survey allows cross referencing of answers for consistency.

The questionnaire consists mainly of six sections of 190 questions relating to: socio-economic features of the household and the farm, main information sources, people involved in decision making, main goals and objectives, attitude to change and animal and pasture management. It focuses mainly on beef production. A translated version of the Thesis and Equipos questionaires are presented in Appendix 6.D and 6.E respectivelly.

A combination of quantitative, open-ended, multiple choice, scale and dichotomous answer formats and closed and structured questions are used. Nominal, ordinal, interval and ratio scales of measurement are applied. The most important questions are appear approximately in the middle of the questionnaire in order to obtain the most accurate answers (Tull 1987; Sierra 1987; Kinnear and Taylor 1989; Aaker and Day 1992).

6.3.2. Definitions

In order to provide an adequate framework for the study, it is necessary to adopt some definitions.

The unit of analysis is the Farming Decision Making Unit (FD-MU), defined as the group of people that participates and influences more actively the decision making process in the farm family system.

The unit of observation is the farm, being all the surface area that is totally or partially used for agricultural production, and it is developed as a technical unit by one person or several, without consideration by way of tenure, legal condition, surface or location (Uruguay MGAP-DIEA 1983).

Technical unit (UT) is the one which has under the same administration unit control, the same resources of production such as: machinery, labour, animals and facilities (Uruguay MGAP-DIEA 1983).

The interviewed is the person who makes the main decisions concerning the administration of farm resources and family. In most occasions this person was the farmer himself.

6.3.3. Data Collection

The aim was to record information about the farm-family system, its information sources, and the animals and pasture management decisions which are the basic concern of the FD-MU.

The interviews were carried-out during the period lasting from 10 December 1993 to 29 April 1994. All the stratified random sample of 81 cattle farm-family decision makers were interviewed by the author. In practically all the cases, an appointment was arranged by phone before hand or by an introductory meeting held. In some cases, it was necessary to have the support of people working in the extension services so as to secure an introduction to the farmer. Only one of the interviews was carried out at INIA - Tacuarembó; the other farmers were interviewed in their homes or farms. The first point was to clearly identify the sponsor (INIA) and explain the purpose of the research and the confidentiality of the information obtained for the study.

The interview was handled in a colloquial way, the answers being writing down on the questionnaire forms. For some questions, however, it was essential that the farmer filled in the answers him/herself. The style of the interview was adapted to each farmer in order to provide all the elements for the interviewee to come up with the most objective and accurate answers, and to avoid making comments which could introduce the interviewer's bias. Interviews varied in length: the largest was 3 1/2 hours and the shortest 45 minutes. The objective was to take the necessary time to ensure a good communication process between the interviewee and interviewer. Only one farmer did not agree to be interviewed. In the rest of the cases they all showed interest and collaborated with the work.

6.3.4. Questionnaire coding and data base development and analysis

Answers check and coding

Once the questionnaire ended, questions were all checked for consistency and coded. The checking and coding of each questionnaire form was useful in order to standardise the information and eliminate inconsistencies. In the case of non-numeric responses and open-ended questions, the answers were coded for data analysis using the SPSS[8]PC (1993) program. The non-numeric responses were also written in textual mode to maintain the original reply from the farmer. Once the coding dictionaries were compiled and checked for each questionnaire, the information was ready to be entered in a data base.

Thesis Data Base

The development of a data base was essential for the analysis. The data base was made taking into account the statistical packages and spreadsheets used for the analysis of the data. The data base was developed using dBase III[9]. The main reasons for choosing this software product were:

- To facilitate data input. A programme was specially designed that would control data consistency and minimise errors.

- The possibility of managing large data sets.

- The format's compatibility with statistical packages (SPSS, SAS) and spreadsheets (Excel and Lotus) programmes.

[8] Statistical Package for Social Sciences ®

[9]dBASE, Ashton-Tate´s relational database management system for microcomputer systems.

Two packages were tested for the analysis: SPSS and SAS (SPSS Inc, 1993; SAS Institute, 1993). After studying the features of both them, it was concluded that SPSS provided a better interface for the data to be analysed in this particular study. SPSS for Windows provided a convenient data editor (spreadsheet-like) for creating and editing SPSS data files. This software has a "friendly" editor which allowed the exchange of information between files generated with other software applications in an easy way. In order to handle the information in a better way, for the analysis, the data was stored in five data sets, maintaining the same order as that used in the questionnaire. All the data was checked to correct any input mistakes.

Equipos Data Base

All the questionnaire forms returned by the farmers interviewed in the thesis were numbered according to the number of sequence interview. In order to use the information collected from the new survey along with the Equipos' survey, the same number the interview was given to the Equipos questionnaire forms. The questionnaire forms corresponding to the same number of farmer in the THESIS sample and in Equipos' survey were all analysed, but not all the questions in the Equipos' survey were included. Not all Equipos-data base information was used; only those questions considered relevant to the objectives of the work were included. Equipos data was taken from the original questionnaire forms and input in the data base for it to be integrated for the analysis with the THESIS survey. The data was entered into a data base maintaining the thesis format.

6.4. Survey Results and Analysis

The results obtained, represent the analysis of the 81 farmers randomly selected. They not only include information achieved through the present survey but also some data on the same farmers taken from Equipos' survey. Tables in the Appendix show the source of information indicating whether Equipos or the THESIS survey corresponds to.

6.4.1. Data Analysis

A descriptive statistical and qualitative analysis of the data from the two surveys was carried out. This descriptive analysis presented the main socio-economic information sources, attitudinal and managerial features of the farm family systems and FD-MUs as well as showed some association between key variables such as farmer's age and education. The variables were divided into categorical (nominal and ordinal) and quantitative (discrete and continuous). Frequencies and cross-tabulations were calculated to describe the differences between the variables. The chi-squared test (χ^2) was issued to test the association between variables[10]. For the quantitative

[10] In most of the studies, the derivation of the Chi-square distribution, as an approximation to the distribution of the test statistic χ^2 when the hypothesis of independence is found to be correct, is made under the assumption that the expected frequencies are five or more. About this point, Cochran (1954) and Everitt (1992) said that this standard precept is too strict. Everitt also said, on the basis of Lewontin and Felsenstein (1965), Slakter (1966), Roscoe and Byars (1971) and other works, that many of the affected values may be as low as unity, without affecting the test greatly and also established that, in the majority of the cases, the Chi-square test may be used for Tables with expected values in excess of 0.5 in the smallest cell. According to Cochran (1954) the requirements that the values needs to have for the calculation of Chi-square is that the cells with no value not be more than 20 percent. Then the approach used in this work to analyse χ^2 results, is that

variables, the mean and the standard deviation was estimated. One-way analysis of variance and least-significant difference was used to test numeric comparisons.

6.4.2. Results and Discussion

Farmer and family description

The farmers were mainly males over 50 years (54.1 percent). Their wives or partners were relatively younger than them and only 3.7 percent did not have children. The average family size was of 4.6 people. The modal value for the age of the youngest child was between 20 to 29 years old. The average farming experience of the farmer was of 25.0 years with an average of 23.9 years spent farming in the current farm. Most farmers were married (84 percent) and only 3.7 percent of the farmers were women. Property transfer was mainly to a relative (66.6 percent) and 26 percent of the farmers got the land through purchase or tenancy. 58 percent are individual owners of the land and 42 percent work in partnerships. All the respondents had a basic minimal education and 23.5 percent had a university degree. The majority of the farmers, partners and eldest children, have a medium education level, having finished high school. In the case of the eldest children, most of them (47 percent) had studied or were at medium education level (polytechnic) and 10.7 percent had completed university. Most of the farmers (67.9) and their families (87.7) live away from the farm. Only an 8.6 percent of the farmers were thinking of retirement (Appendix 6.B; Tables 6.1 to 6.10).

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the expected values need to be greater than 0.5 and the cells with no value be no more than 20 percent. The value of the minimum expected frequency is going to be presented.

58 percent of the farmers do not have an off-farm activity. The most common off farm activity is that of working as a professional or as a rural auctioneer. In average, 78 percent of the farmer income cames from farming activities and 22 percent from off-farm activities. The main reason for having an off farm activity is that the off-farm and the on-farm activities are complementary financially necessary, or provide a chance to diversify income. Only 21.1 percent of the wives or partners, and 23.9 percent of older children work on the farm. In the case of a wife or partner having another job, they consider that 66 percent of their income cames from the off-farm activities (Appendix 6.B; Tables 6.11 to 6.13).

The Chi-Squared Test (χ^2) to test put through the association among variables. Farmer's age and education were tested against off-farm work, the size of the farm, ownership and property transfer (Table 6.3). Relatively young farmers are highly educated, have a higher percentage of off-farm job, own the largest farms, manage the land mainly through a partnership, and the most common way of accessing to land is through a family relationship. Farmers over 50 years of age have a low level of education, are mainly dedicated to the farm, own the smallest farms, manage the farms as an individual ownership and gained access to the land via a relative or through purchase and tenancy (Appendix 6.B; Tables 6.14 to 6.22).

Table 6.3. Some features of the farmer, showing χ^2 level of significance[11]

Variables	Age of the farmer	Education
Formal education	**	--
Off-farm activity	**	**
Size of the farm	**	NS
Ownership	**	**
Property transfer	**	**

The results on the relationship between off-farm activities and the education level are concordant with information presented by other authors (Corcoran and Dent 1994).

Farmers' attitude to change

In order to test farmers' attitude to change, they were asked whether they were interested in diversifying farm activities. 46.9 percent of the respondents were not interested in diversifying their farms (Appendix 6.B; Tables 6.23 and 6.24). Farmers' interest in diversification is not associated to age or and formal education (Table 6.4). Farmers were not thinking of introducing any changes in beef and sheep production practices at a rate of 65.4 or 73.1 percent respectively (Appendix 6.B; Tables 6.25 to 6.28). Young and more educated farmers showed more interest than farmers over 50 years old in planning changes in beef production. In the case of sheep production, there exists an association to education but there is no association with the age of the farmer (Table 6.4).

[11]For all Tables * indicates significant at 10 percent, ** indicates significant at 5 percent and NS no significant, -- indicates that the expected value are below 0.5 or there are more than 20 percent of cells without value.

Table 6.4. Farmer change attitude variables, showing χ^2 level of significance

Variable	Age	Education
Interest on farm diversification	NS	NS
Planning changes on beef production	*	*
Planning changes on sheep production	NS	*

The information presented shows that the majority of the farmers are not interested in changes. Nevertheless, younger and more educated farmers are more interested in making changes to their beef production system.

Main sources of information and use of support decisions

The main sources of information are brokers and auctioneers (25.9%), the family (22.2 percent), advisers (19.8 percent) and mass media (17.3 percent) (Appendix 6.B; Table 6.29). There is no association between the age of the farmer and the main sources of information (Table 6.5). Farmers mainly search for prices locally and usually buy from the same supplier (Appendix 6.B; Table 6.30). 61.7 percent of the respondents purchased from local suppliers and only 6.2 percent of the farmers looked for prices at national level.

Farmers keep records on expenses and income mainly (45.7 percent), compulsory records of livestock (23.5 percent) and climate records (19.8 percent). Only 6.2 percent of the farmers have production records (Appendix 6.B; Table 6.31). The association between record keeping and age suggests that older farmers keep relatively more compulsory and climate records than younger farmers under 50 years (Appendix 6.B; Table 6.31[12]).

Farmers answer that the main reasons for keeping records are: because they are necessary to management of the farm (40.7 percent), because it is compulsory (40.7 percent) and as an excuse to have papers in order (18.5 percent) (Appendix 6.B; Tables 6.32 and 6.33).

Table 6.5. Main sources and use of information variables, showing χ^2 level of significance

	Age	Education
Main sources of information	NS	--
Farmers search field for prices	**	--
Records kept by the farmer	**	--
Main reasons to kept records	NS	**
Farmers' main use of records	**	**
Farmers' production costs knowledge	NS	NS
Farmers' key information for support decisions	NS	**
Farmers' type of information for support decisions	NS	**
Differential use of informal and formal information	**	**
Main use of formal information	**	--

There is no association between age and the main reasons for keeping records, but there is a significant association between education and record keeping. More

[12] Respondents were asked to rank order records (Appendix 6.D).

educated farmers say they keep records in order to run the farm, while farmers with lower education keep records mainly because it is compulsory to do so.

Farmers were also asked about the main use of records, and answered that it is to understand the farm's situation (28.4 percent) and to assist them in making investment decisions (13.6 percent). In relation, younger and more educated farmers, keep and use more records (Appendix 6.B; Tables 6.34 and 6.35).

Only 29.3 percent of the farmers know their production costs (Appendix 6.B; Table 6.36). The testing this variable against the age and formal education of the farmer, the agroecozone and size of the farm, indicated that there is a significant association only with the agroecozone (Appendix 6.B; Tables 6.36 to 6.40). Farmers from shallow soils have less knowledge about the level of their production costs, because a higher percentage do not keep records.

Farmers were asked about what they considered to be key information used in making decisions on the farm (Appendix 6.B; Tables 6.41 and 6.42). 44.4 percent them answered it was market information, 23.5 percent that it was farm records, and 22.2 percent that they both were. The analysis shows that 57.9 percent of the farmers with university degrees (11.1 percent of the farmers) support their decisions using farm records and market information, while 42.9 percent of with middle-level of formal education (11.1 percent of the farmers) prefer to base their decisions on farm records and 68.4 percent of farmers who reached only high school education (16.0 percent of the farmers) are inclined to use only market information.

Related to the use of formal or informal information as a support for deciding, 54.3 percent of the farmers said they based their decisions mainly on informal information. There is no association between the age of the farmer and the type of information used. However, the results indicate that more educated farmers use more formal information and less educated farmers base their decisions mainly on informal information (Appendix 6.B; Tables 6.43 and 6.44). The statistical analysis shows that age and education are associated to a different usage of formal and informal information (Appendix 6.B; Tables 6.45 and 6.46). 68.2 percent of the farmers older than 50, (37.0 percent of the farmers) use mainly informal information for support decisions. However, 61.9 and 62.5 of young and middle-aged farmers use both types of information but in a different ways depending on the type of issue to be decided upon. The main use of formal information concerns planning and investment 23.5 percent and 43.7 percent respectively (6.2 and 8.6 percent of farmers), for loan applications, 14.2 and 12.5 percent (3.7 and 2.5 percent of the farmers) of the young and middle-aged farmers respectively (Appendix 6.B; Table 6.47).

The results suggest that farmers have some routines in their information search, being based mainly on informal local sources. Younger and more educated farmers have a broad field of information search and sources. The latter are more inclined to use farm records for supporting decisions, mixing formal and informal information.

Farmers' decisions and the use of analysis for support decisions

In order to know more about how information is used and processed, farmers were asked about the use of analysis or intuition to support farming decision making (Table 6.6). A large number of farmers use both formal analysis and intuition to support their decisions (48.1 percent). Intuition is used predominantly by 37.0 percent of the farmers and only 14.8 percent support their decisions mostly based on analysis (Appendix 6.B; Tables 6.48 and 6.49). The less educated farmers base their decisions mainly on intuition while more educated farmers use both types of information to support their decisions. Farmers say that investing decisions (42.0 percent), loan applications (18.5 percent) and the introduction or changes in production activities (9.9 percent) are the issues that require more formal analysis (Appendix 6.B; Table 6.50).

Association was found between the age of the farmer and the type of decision they think requires for advice. The majority of the farmers (53.1 percent) think that they require advisory support regarding production decisions and that they also need to concentrate their efforts on these decisions (66.7 percent) (Appendix 6.B; Tables 6.51 and 6.52) Some young farmers think they need advice for commodity changes whilst no farmer older than 50 thinks about commodity changes.

Table 6.6. Farmers' decisions (analysis of variables) showing χ^2 level of significance

	Age	Education
Farmers' use of intuition or analysis	NS	**
Farmers' decisions that require more analysis	NS	--
Farmers' decisions that they think need advice on	**	--
Decisions farmers think need to concentrate efforts on	NS	--

Farmers and the use of computers

21 percent of farmers own a computer. The association of this variable to the education and the age of the farmer, indicates that younger and more educated farmers are more likely to have a computer (Table 6.7) (Appendix 6.B; Tables 6.52 and 6.53).

Farmers answered that lack of understanding (32.1 percent), no obvious justification or interest (18.5 percent) or other priorities for expenditure (16.0 percent) were the main reasons why they did not buy a computer. Of the 21 percent of the farmers who own a computer, only 13.6 percent use it on the farm. All the farmers that use computers on the farm, do so for economic and financial analysis (Appendix 6.B; Table 6.55 and 6.56). Young farmers are significantly more inclined to own and use a computer on the farm. These results suggest that computerised decision support systems designed to be used directly by the farmers will be found useful to only a small percentage of farmers.

Table 6.7. Computers and their use showing χ^2 level of significance

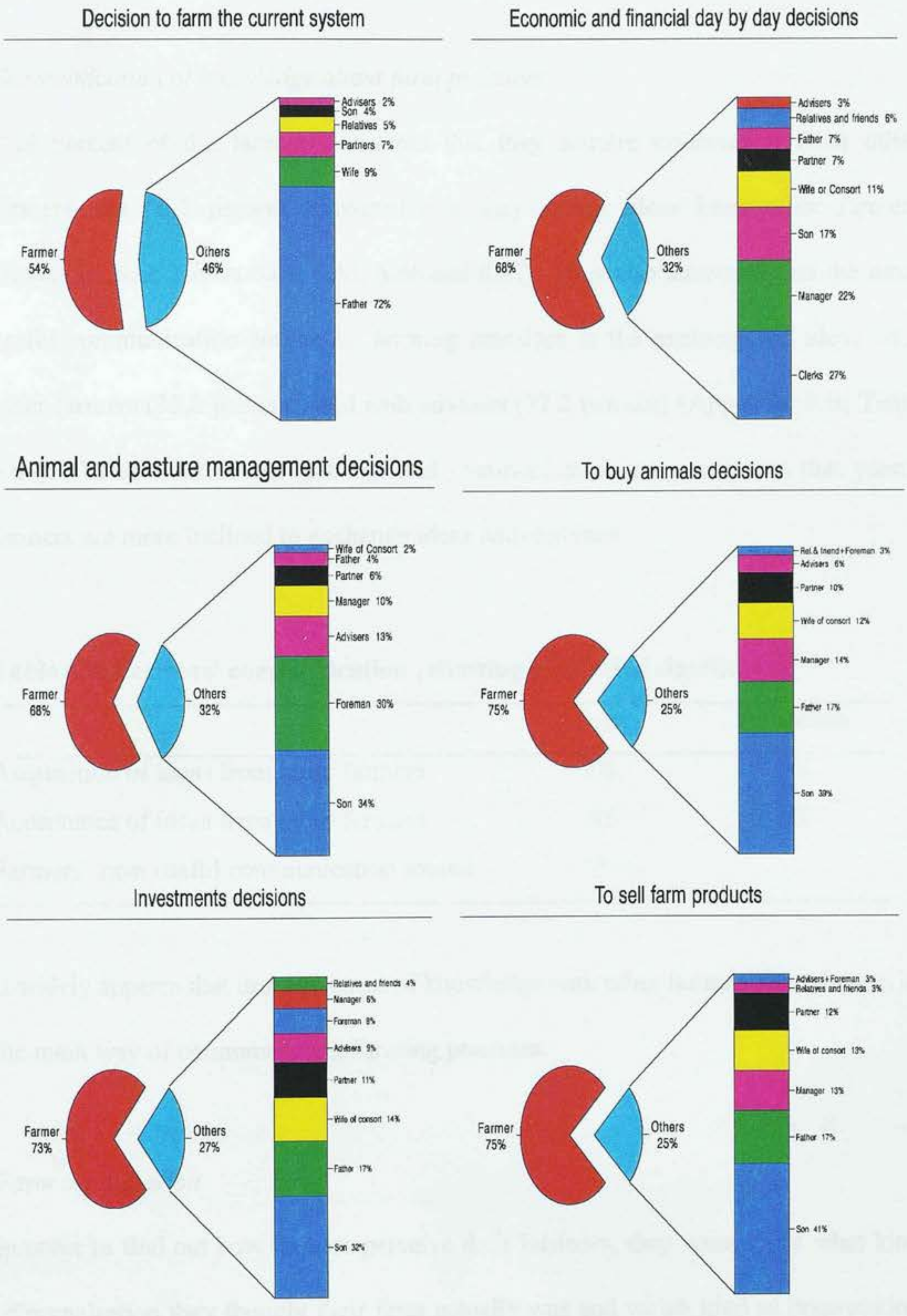
	Age	Education
Farmers who own a computer	**	**
Farmers' reasons for not having a computer	NS	--
Use of computers on the farm	**	--

Farming decision-making-unit description

In all the types of decisions studied, the farmer was highly influenced in farm decision making (Appendix 6.B; Tables 6.58 to 6.63). Farmers, however, share decision making with a variety of different people and these change according to the type of decision[13] (Figure 6.5). This suggested that farmers trust different people according to the type of decision being made. Nevertheless, the family has the major influence in almost all the cases considered. The information also shows a clear intergenerational relationship in the decision making unit, where three generations make important contributions towards decision making. In decisions relating to the managing of the current system, the influence of the father is very important; but in relation to decisions regarding the management of animals and pastures as well as their purchase, and sale, the eldest son is influencing. Only in the case of day to day decisions do farmers share opinions with non-relatives such as clerks and the farm manager. The results suggest that farmers support their decisions based mainly on their "trusted people". Also, that farmers' trust in different people varies according to

[13] Farmers were asked to compute his perception about the degree of his own and "trusted people" percentual involvment in decision making (Appendix 6.D; questions 23, 37, 80 and 81).

Figure 6.5. People involved in the farming decision making unit by type of decision.



the type of decision to be made. Therefore, the FD-MUs seem to have a flexible integration and fuzzy boundaries that are adjusted according to the type of decision.

Communication of knowledge about farm practices

77.8 percent of the farmers answered that they acquire information from other farmers and 66.7 percent answered that they accept ideas from other farmers (Appendix 6.B; Tables 6.64, 6.65, 6.66 and 6.67). They also answered that the most useful communication source on farming practices is the exchange of ideas with other farmers (35.8 percent), and with advisers (27.2 percent) (Appendix 6.B; Table 6.68). The association between age and communication sources shows that young farmers are more inclined to exchange ideas with advisers.

Table 6.8. Farmers' communication , showing χ^2 level of significance

	Age	Education
Acquisition of ideas from other farmers	NS	NS
Acceptance of ideas from other farmers	NS	NS
Farmers' most useful communication source	*	--

It widely appears that oral exchange of knowledge with other farmers and advisers is the main way of communicating farming practices.

Farm organisation

In order to find out how farmers perceive their business, they were asked what kind of organisation they thought their farm actually was and which kind of organisation they thought was the best for farming. 64.2 percent of the farmers answered that mainly had a family organisation, 18.2 percent that had a family business and 17.3 percent that they mainly had an entrepreneurial organisation (Appendix 6.B; Tables 6.69, 6.70, 6.71, 6.72). When they were asked about what type of organisation they thought was the best, 32.1 percent answered the entrepreneurial. The association between education, age and organisation indicates that young and more educated farmers are more inclined to organise the farm as an enterprise. Conversely, these less educated and older than 50 prefer a family organisation (Table 6.9).

Table 6.9. Farm organisation variables, showing χ^2 level of significance

	Age	Education
Present farm organisation	**	**
Farm organisation they think is the best	**	**

Farmer's use of formal planning

In order to find out farmers' interest in a formal mechanism for the formal planning of activities, they were asked about frequency and period of planning. 40.7 percent almost never plan their activities and only 12.3 percent always plan their farm activities (Appendix 6.B; Tables 6.73 and 6.74). Education and the use formal planning of activities were found to be associated, indicating that farmers who use to plan their activities tend to be more educated and thus mainly makes plans for a year in advance (Table 6.10). 40.7 percent of the farmers responded that they mainly plan their activities for a one year period, 30.9 percent answers indicate that they plan their activities for less than 6 months and 28.4 percent of the farmers never formally plan their activities (Appendix 6.B; Tables 6.75 and 6.76). An association was found between age, education and the period they planning their activities for (Table 6.10). Young farmers tend to plan activities over less than 6 month period and farmers 50 years old or over set horizons of one year, because young farmers perceive that is not possible to plan over a period of 6 mont given the prices and production variability. More educated farmers almost always plan their goals over a period of one year. Most of the farmers responded, that they do not apply a formal planning mechanism because they manage the farm in a similar way each year. Only minor adjustments are introduced in order to drive the production system towards their goals.

Table 6.10. Farmers' planning activities, showing χ^2 level of significance

	Age	Education
Frequency of planning activities	NS	*
Period of planning activities	*	**

Production system description

52.0 percent of the farms in the survey are located on shallow soils, and the preferred system of production is mixed grazing of cattle and sheep (79.0 percent) (Appendix 6.B; Tables 6.77 and 6.78).

In average across the whole area, the main activities in beef cattle production are: complete cycle (37.0 percent) cow-calf (33.3 percent), and finishing (11.1 percent). An association was found between education and the main activity of beef and sheep production (Table 6.11) Results suggest that more educated farmers prefer complete cycle activity. For 52.0 percent of the farmers who have medium level of formal education and for 47.0 percent of farmers who have finished university, the preferred activity is complete cycle (Table 6.11) (Appendix 6.B; Table 6.79). Less educated farmers prefer cow-calf management systems. The main activities in sheep production are complete cycle (74.4 percent) and sheep lamb breeding (25.4 percent). Farmers with a higher level of formal education are relatively more inclined towards complete cycle systems whilst the less educated tend towards sheep breeding (Appendix 6.B; Table 6.80).

Table 6.11. Production system (main activities, showing χ^2 level of significance

	Age	Education
Farmer preferred working system	NS	--
Main activity on beef cattle production	--	**
Main activity on sheep production	--	**

The average size of the farms is 2789 hectares (Appendix 6.B; Table 6.81) and the mean stocking rate is 0.81 animal units per hectare where 0.43 correspond to sheep, 0.35 to beef cattle and 0.03 to horses. These indicators show that the system is more orientated towards sheep production. Weaning percentage is of 51 percent in cattle production and 65 percent in sheep production. Of the total land, 3.1 percent are improved pastures and 3.53 is dedicated to crops. Wool production was recorded at an average of 7.41 kilograms per hectare and 3.4 kilograms per animal. The average production cost (from respondents with knowledge about such costs) was US$ 29.42 per hectare. An average farm employs 6 permanent labourers, which means that one labourer manages 464.8 hectares. The results show that farmers manage an extensive system, with very low percentage of improvements and cash crops. As a consequence, the productivity of beef and sheep is also very low.

Pasture and feed management facilities, control rules and strategies

Table 6.12 provides a summary of the main animal and pasture management facilities and the levels of association with age and education. The farms were recorded as having an average of 9.9 permanent paddocks with an average size of 282 hectares (Appendix 6.B; Table 6.81 and 6.82). The majority of farmers (74.1 percent) do not use electrical fences to manage animals and pastures (Appendix 6.B; Tables 6.83 and 6.84). Only 4.9 percent of farmers routinely supplement animals with grain in winter, 51.9 percent never supplement the animals and 43.2 percent only do so during exceptional stress conditions (drought) (Appendix 6.B; Table 6.84). 71.6 percent of farmers agree that best quality pasture needs to be used for finishing animals (Appendix 6.B; Table 6.86 and 6.87). The main objectives of managing pastures are to feed animals as best as possible (51.9 percent), to maintain natural pasture species (19.8 percent) and to improve the soil (11.1 percent) (Appendix 6.B; Table 6.88).

This information suggests that 48.1 percent of the farmers have environmental objectives that appears mainly related to pasture management. An important issue in pasture management is the determining of pasture quality. The main criteria farmers use for quality determination are animal weight gains (50.0 percent), legume

Table 6.12. Animal and pasture production system management facilities and rules, showing χ^2 level of significance

Variables	Age[14]	Education[15]
Size	NS	NS
Agroecozone	NS	NS
Main seasonal production bottle neck	NS	--
Main strategy to cope with seasonal production bottle neck	NS	--
Inclusion of a new feeding practices in the future	NS	--
Number of paddocks	NS	5*/1,2,3,4
Use of electric fence	NS	NS
Percentage of improved pastures	NS	4*/5*/1,2,3
Percentage of cropped land	NS	1*/2,3,4,5
Winter supplementation with grain	NS	--
Use of best pasture to finishing animals	NS	NS
Main objectives with pastures	NS	--
Pasture quality rule base	NS	--
Pasture management rule base	NS	--
Animals management rule base	NS	--
Stocking rate	1*/2,3	NS
Beef stocking rate	NS	4*/1,3
Sheep stocking rate	1*/2	NS
Weaning percentage on cattle	NS	--
Weaning percentage on sheep	NS	--
Frequency of counting animals	NS	NS

[14]Age categories are respresented as follows: 1 means 20-39, 2 means 40 to 50 and 3 more than 50 years old.

[15]Education levels of formal education are thus represented: incomplete primary 1, complete primary and incomplete high school 2, complete high school 3, polytech and others, 4 and complete University 5.

availability (15.4 percent) and total pasture availability (15.4 percent) (Appendix 6.B; Table 6.89).

Farmers identify winter (76.5 percent) and summer (23.5 percent) as the main seasonal bottle-necks for animals and pastures (Appendix 6.B; Table 6.90). The strategies followed by the farmers to cope with these seasonal constraints are: to improve natural pastures (28.4 percent), to agist animals (16.0 percent), to sell animals (14.8 percent), to cultivate forage crops (7.4 percent), other strategies (8.6 percent) (Appendix 6.B; Table 6.91). 24.7 percent of the farmers do not have any particular strategy to cope with the stress periods, while 67.9 percent are considering the inclusion of new practices for animal feeding in the future (Appendix 6.B; Table 6.92).

In order to manage the pasture, and rotate the animals, the farmers use rules that are based on the height of the pasture (60.5 percent), on the volume of green pasture (24.7 percent) and the colour of the pasture (6.2 percent) (Appendix 6.B; Table 6.93). For animal management the most common criteria used is to score their condition (90.1 percent) and only 4.9 percent of the farmers use the scales as a complementary measure to adjust the score condition criteria (Appendix 6.B; Table 6.94).

With the aim of getting an idea of how frequently farmers monitor animal production, they were asked about the frequency with which they count the animals.

54.3 percent of the farmers count their animals every month, 14.8 percent do so every two months and 30.9 percent do it in for periods longer than two months.

The use of credit and labour

37.0 percent of the respondents answered that they use borrow money (Appendix 6.B; Tables 6.97 and 6.98). No association was found between farmers' age and formal education and the practice of borrowing money (Table 6.13). Of those not using borrowed money, most state that the reasons for not doing so is related to the variability of product prices and the high rates of interest charged.

65.4 percent of the farmers responded that labour is a constraint to the adoption of new technology. They say that the problem is not only the availability of labour, but also the need to find people with the necessary skills and education to do the job.

Table 6.13. Credit and labour availability, showing χ^2 level of significance

	Age	Education
Use of credit	NS	NS
Labour as a constraint	NS	NS

The scope of the extension and research complexes

In order to obtain some indicators of the scope of the extension and research complex, farmers were asked about their use of external advice, their perception of new technology, their adoption of technology in recent years, the use of extension services and their contact with research institutions (Table 6.14).

Table 6.14. Scope of extension and research indicators, showing χ^2 level of significance

	Age	Education
Farmers' use of advice	NS	NS
Farmers' use of agronomic advice	NS	**
Farmers' use of veterinary advice	NS	NS
Farmers' perception of new technology	NS	NS
Farmers' interest in applying the latest technology	NS	NS
Farmers who have improved the farm	NS	*
Farmers who have been working with Plan[16]	NS	**
Farmers who had visited a research institution	*	**

40.7 percent of the farmers answered that they had received some kind of advice (Appendix 6.B; Tables 6.101 and 6.102). No significant association was found between the use of advice and the age and formal education of the farmer. Farmers were asked about the use of agronomic and veterinary advice in order to find out more specifically what kind of advice they had received. 28.4 percent answered that they had received agronomic advice, while 60.5 percent had received no such input (Appendix 6.B; Table 6.103).

An association was found between the use of agronomic advice and farmers' formal education. The results indicate that the more educated farmers are more likely to seek advice (Appendix 6.B; Table 104).

[16]National livestock extension services and credit.

Veterinary visits[17] are more common amongst farmers (92.6 percent) (Appendix 6.B; Table 6.105 and 106). However, only 40.7 percent (Appendix 6.B; Table 6.101) of the farmers replied that they had received veterinary advice.

90.1 percent of the farmers answered that they consider it necessary to introduce new technologies in order to compete at an international level (Appendix 6.B; Tables 6.107 and 108). But when they were asked about their interest in latest technology and when they had incorporated it in recent years, only 34.6 percent of the farmers showed interested (Appendix 6.B; Tables 6.109 and 6.110). In this case positive association was found between education and recent farm improvement (Appendix 6.B; Table 111 and 112).

Only 35.3 percent of farmers have been working with the public extension services of the Plan Agropecuario. Young farmers and those with a high level of formal education are more likely to employ the services of the extension services (Appendix 6.B; Table 113 and 114). 70.4 percent of the farmers had never visited an agricultural research institution, 14.8 percent had visited INIA and 14.8 percent had visited other research institutions (Appendix 6.B; Tables 115 and 116).

[17]Through the compulsory vaccination plans against brucelosis and foot mouth diseases farmers were required to justify through a veterinary certificate in the first case, and through an official receipt in the second place that all the required categories had been vaccinated. The 1 to 5 compulsory visits are just the ones in the vaccination plans and can not be considered veterinary advice.

Farmers' objectives, personal goals and sources of satisfaction

The purpose of this section is to describe farmers' main objectives and the sources of satisfaction to farmers in the survey (Table 6.15). 35.8 percent answered that the main objective was to increase farm output, 21 percent wished to provide good schooling for their children, 12.3 percent wished to maximise income and 6.2 do not wish to have debts (Appendix 6.B; Table 6.117). Association was found between farmers' objectives and his/her age. Middle-aged farmers emphasised their desire to increase output and to maximise income whereas providing schooling for children was relatively less important.

Table 6.15. Farmers' objectives, source of satisfaction, reasons for farming, and farm income perception, showing χ^2 level of significance

	Age	Education
Farmers' objectives today	NS	--
Farmers' objectives three years ago	NS	--
Farmers' important personal goals	NS	--
Farmers' main source of satisfaction	NS	--
Farmers' main reasons to continue farming	**	--
Farmers' satisfaction from their work	NS	NS
Farmers' farm income perception	NS	NS

Another important issue is how often farmers change their strategies in order to manage the farm. To explore this point, farmers were asked what their three main objectives were three years ago (Appendix 6.B; Table 6.118). 65.4 percent of the farmers indicated that they had not changed their objectives.

Farmers answered that the most important personal achievement was: to be a good farmer (29.6 percent), to be a prestigious farmer (19.8 percent), to belong to a farmers' group (18, 5 percent), to have recognition from society for their work (17.3 percent) and to maintain an active social life (14.8 percent) (Appendix 6.B; Table 119). This means that farmers' social achievements are related to their activities as farmers.

40.7 percent of farmers answered that independence at work is the main source of satisfaction, while 17.3 percent cited working with nature, and 14.8 percent said they took pleasure in farm work (Appendix 6.B; Table 120). Again, results show strong links between farmers' sources of satisfaction and farm-working features.

In 37.0 percent of the cases the main reason to continue farming was to pass the farm on to the next generation and in 6.2 percent were concerned of when the farmers giving education to their children (Appendix 6.B; Table 6.121). The association with age suggests that older farmers continue farming mainly to pass the farm on to the next generation, and young farmers are more concerned with economic reasons.

88.9 percent of the farmers are happy being a farmer (Appendix 6.B; Table 6.122) only 6.2 percent of the farmers answered that the income they obtain from the farm is good, while 43.2 percent were dissatisfied with their farming income.

6.5. Summary of considerations

The main interest of this chapter has been to describe the methodology and to present some general results of the population under study. In order to study the farm family decision processes, the strategy applied involved the use of different data collection techniques and the combination of quantitative and qualitative research methods (Section 6.2). In this way, it was possible to combine methods that allowed for the characterisation and classification of the FD-MUs' population based mainly on static information (secondary sources and surveys) to select three rich information case studies. Analysing the cases, it was possible to study the micro-dynamics and evolution of the farm family decision making process.

This Chapter described only the main features of the whole sample of FD-MUs. In order to test the association of the variables analysed, farmers' age and education were considered mainly. However, with these results, it is not possible to depict more than a general description.

The results suggest that, on average, there is a strong link between the family, the "trusted people" and the farming system. The main way to transfer property is through a relative, showing strong intergenerational links with farming activities. The farmer is the kernel of the decision making unit. The farmer, the family and the "trusted people" are the main components of the FD-MU. Information suggests that farmers have a routine composed of "trusted people" in whom they confide and who provide local information to support decisions. Such information is checked against their own experience, criteria and beliefs. There is total predominance of males in farming activities and decision making. It appears that farmers do not change their objectives very often because they have a behaviour routine which controls the stability of the farm-family system. This behaviour routine is shown in the sources, information search, , processing and programming. and type of information used The control and the monitoring of the system is based mostly on heuristic rules and local knowledge. Information suggests that farmers do not change their strategic decisions until some external influence forces them to do so. The research and extension complex is targeting on less than 40 percent of the farmers. Clearly, the majority of the farmers are not targeted by the actions of the research and extension complex. It is imperative to undertake some action in order to improve the efficiency and to better target farmers' needs.

The predominant production system is extensive and has low performance indicators. The main objectives, personal achievements and sources of satisfaction are thoroughly connected to the farm and the family. Income maximisation and economic results are not the main objectives of most FD-MUs. Therefore, economic and financial optimisation are not the most important achievements that guide farming decision making. Nevertheless, results show that there are differences within the population of farmers mainly associated with the farmers' age and education.

Chapter 7

Farm Decision Making Units' Classification

7.1. Introduction.

The average results of the data analysis, presented in Chapter Six, are not enough to provide an explanation about the different patterns of behaviour adopted by farmers. In Chapter Six, a descriptive analysis of the FD-MUs was presented based on the modal, average or predominant behaviour. Now it is widely accepted that not all FD-MUs respond to the working environment (agricultural policies, research and extension complex actions, climate) in the same way (Dent 1994; Grau and Paolino 1995). The needs and problems of FD-MUs vary according to their agro-ecological and socio-economic conditions (Williams 1994). One of the hypotheses of this work is that it is possible to identify and classify groups FD-MUs, and, on the basis of the information obtained, depict the main features of the FD-MUs. Williams, (1994) points out that recommendation domains have been defined by different authors " *as a group of farmers with similar practices and circumstances for whom a given recommendation would be broadly appropriate"*. As a consequence, it is possible to identify recommendation domains that can help the research and extension complex to target better their activities, allocate the resources more efficiently and develop more effective farm decision support systems.

The next step towards a better understanding of the decision making process is to identify a method of recognising and describing the principal types of FD-MUs in the cattle and sheep production systems prevailing in the basaltic region, and to investigate, within these types, what the most relevant characteristics are and their relationship with the decision making process at farm level.

The objective is to explore and, if possible, find an FD-MU classification, test some of the hypothesis developed in Chapter 5 and target better the selection of the case studies, based on a wide range of variables in the two surveys described in Chapter 6.

A classification scheme may simply represent a convenient method for organising a large data set (Everitt 1993) in order to establish different types of FD-MU systems. Cluster and discriminant analysis are statistical procedures that can be used to provide logical and systematic methods of classification.

In this chapter, factor, cluster and discriminant analysis is used for:

• Classifying FD-MUs into recommendation domains that can help to target better the research and extension complex.

• Exploring and analysing within each identified group if it is possible to find different behaviours and types of FD-MUs.

• Analysing the different objectives, information sources, processing, analysis, evaluation and control rules used by each of these FD-MU types in order to elicit the elements that can be used to depict a first description of decision support systems (formal, mental or hybrid model) in real use. In this way it may be possible to characterise the different patterns of decision making at farm level.

• Providing a systemic and logical method of classification which is considered an appropriate framework for identifying individual FD-MUs within each group in order to develop an in-depth case study.

• Providing elements to test the hypothesis developed in Chapter 5.

7.2. Information sources.

The information used for this analysis was taken from 81 farmers over two surveys (Equipos-INIA and the one for this Thesis) and the procedures used were described in Section 6.3.1. The INIA- Equipos data base was divided into two data files and the thesis data base was divided into 5 data files.

Not all the information in the Equipos data set was included, and all redundant information was filtered.

7.3. Methodology for classification.

7.3.1. Farmers and farm classification studies.

A number of statistical techniques were used to help the implementation of the processes of classification (Kaminsky 1975). Different methodologies have been applied to classify farmers and farms for different purposes (Cohan 1975; Ferreira 1975; Jones 1975; Silva and Zanotta 1979; Uruguay MGAP-DIEA 1980, 1981, 1982, 1983, 1986, 1990; Uruguay MGAP-COLEME-IICA 1980; Peyrou and Artigas 1982; INIA 1991; Perkin and Rehman 1994; Fairweather and Keating 1994; Grau and Paolino 1995). The objective of a classification process is to group the units of study and describe them in terms of a set of variables. The present classification studies are targeted at the individual farmer and have the objective of describing and understanding different groups of farmers and farms based on (i) management styles (Fairweather and Keating 1994), (ii) household income (Corcoran and Dent 1994), (iii) farmers' objectives (Perkin and Rehman 1994; Fairweather and Keating 1994), iv) use of paid labour (Alonso and Pérez Arrarte 1982), (iv) integration of improved and traditional systems (Uruguay MGAP-DIEA 1974, 1975, 1986), (v) degree of influence of the market (Murmis 1978), (vi) farmers' responses to risk (Newman *et al.* 1991), (vii) level of income and profitability (Uruguay MGAP-DIEA 1991) and technical efficiency (Grau and Paolino 1995). In spite of the valuable information provided by these studies, they were focused on the individual farmer acting as a sole decision maker, ignoring the family and the "trusted people".

Some of those studies were based on methods that rely on an "ex ante" or "a priori"[1] knowledge about categories of data. These methods involve a classification or identification process and consist of assigning a new observation point of view to a set of already established categories (Veiga 1983; Uruguay MGAP- DIEA 1990). The essential attributes of each category are already known and have very clear and defined limits based on previous interpretative analysis. An example of “ex ante” methodology is discriminant analysis, which requires that the group membership for the cases used is known beforehand to obtain the classification rules (SPSS 1993).

Others methods were based on the use of statistical algorithms to obtain the groupings “a posteriori” or “ex post”[2]. In such analysis the group membership of all cases is unknown (SPSS 1993). These are the cluster analysis techniques which seek to assign members to groups only after carrying out the analysis.

7.3.2. Variables selection and factor analysis

In order to use as much of the information available on the data sets, different procedures for selecting the variables were tested. These procedures range between completely subjective selections of variables, to procedures for selecting the variables statistically (Ferreira 1975; Uruguay MGAP-DIEA 1986). Factor analysis was chosen to reduce the information from the original variables from each data set

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[1] Deductive reasoning from a general principle to the expected facts or effects. Logically prior to all observational experience (Campbell 1987)

[2] Empirical, involving inductive reasoning from particular facts or effects to a general principle (Collins Dictionary 1992)

to a fewer, more important and manageable number of factors or synthetic variables. Factor analysis is used to identify factors which can be applied to represent relationships among sets of many interrelated variables and to reduce subjectivity. The method of principal components was chosen for factor extraction of the variables in each data set. The method of principal components was designed to compute linear combinations of the original variables to reduce them to a small number of indices (Manly 1988). The first principal component is the combination which explains the largest amount of variance in the sample and, through this procedure, the successive components explain progressively smaller proportions of the total sample variance (SPSS 1993). The total variance explained by each factor is presented in the output through the eigenvalue and the percentage of the variance associated to the factor (Appendix 7.B). Principal component is not as objective as other statistical methods and some subjective assumptions need to be made in order to select the number of factors to include in the study; also, a slightly better solution can be obtained by rotating the factors. A scatter plot (Appendix 7.B) was printed for each set of data under consideration and this was used in the selection of the factors.

The descriptors for the factors are presented in Appendix 7.B. Only the main descriptors for use of advice and farm investments data set, are presented, as an example, in Table 7.1.

Table 7.1. Extracted factors and variables more strongly associated to explain the use of advice and farm investments.

Factor	% of total variance explained	Variables correlated positively	Variables correlated negatively
1 Needs of external advice	14.8	• Do not use advice for: - Pasture management - Animal production - Farm management - Loans applications - Agronomic problems • Farmers can cope well with farm problems • Do not invest farm surplus off the farm. • Advice is not important	• Need of advice
2 No compulsory investments	8.1	• In the past 5 years no invest: - buying a pick-up - Beef cattle facilities - Corrals - Wind mills	
3 Compulsory investments	6.1	• In the past 5 years no investments in fencing	
4 Use of farm surplus	5.9	• No invest farm surplus on personal expenses. • No invest farm surplus in a house.	
5	4.4	• No satisfaction with farm income.	• Market prices variability is the main reason to explain no adoption of new technology
6	4.3	• Do not invest farm surplus buying land	
7	3.9	• Reasons to explain farm performance	
8	3.8	• No use of farm records	
9	3.4	• Use of Veterinary advice	
10	3.3	• Do not buy more land	
11	3.1		• Do not savings farm surplus
12	2.8	• Improve pastures is not a risky decision	

The criteria applied to select the factors was on the basis of eigenvalues greater than 1 and an accumulated variance explained by the factors greater than 60 percent (Table 7.2.). This procedure allowed reducing 279 original variables to 77.

Table 7.2. Data set variables reduction to factors, showing percentage of variance.

Data Set	Number of original variables	Number of factors	Percentage of the variance explained by factors
Socio-economic	37	12	75.6
Demographic	35	5	72.7
Decisions and attitude	39	12	75.5
Objectives, satisfactors	19	7	66.1
Animal feeding	22	5	74.9
Information awareness	46	12	63.9
Farm installations	39	12	72.9
Management practices	42	12	72.8
Total	279	77	68.3

In order to give a brief description of the data sets, the variables' highly correlated first factors will be pointed out. As presented in Table 7.1, the first data set includes socio-economic variables like size of the farm, ownership, percentage of improved land, number of animals, agroecozone (soil and pasture quality), decisional variables related to property transfer, weight of the different actors in the decision of the farm's current production system, what the farmers would like to pass on to their children, main reasons to continue working, (Appendix 7.B). The second data set includes demographic data such as age, formal education, sex, residence place and marital status of all family members. Variables related to farmers experience were also included (Appendix 7.B). Decisions and attitudinal factors mainly include variables like people involved in decision making for animal and pasture management, buying and selling animals, inputs and farm products, investments, economic and financial day to day decisions (Appendix 7.B). Objectives and satisfying factors mainly represent variables related to: farmers' three main objectives at the time of the survey and three years before then, as well as social objectives, and sources of satisfaction (Appendix 7.B).

Animal feeding factors are principally related to animal feeding during winter and summer, and the criteria used in order to determine animals' score condition, etc.(Appendix 7.B). Information awareness factors represent variables related to the use of advice, the different types of investments on the farm, etc. (Appendix 7.B). Factors on farm management and production practices mainly represent variables related to the amount of wool produced, the number of cows mated and live calves over the last year, the number of paddocks, electricity power on the farm, etc. Finally, the factors related to animal and pasture management represent variables mainly related to the length of use of improved pastures, to the availability of information for improving pasture production and animal management, etc.

7.3.3. Methods of cluster analysis.

The term 'cluster analysis' is a generic term applied to a range of statistical techniques for data classification (Pielou 1984; Krebs 1989; SPSS 1993). A classification scheme is a convenient method for organising a large set of data by describing both patterns of similarities and dissimilarities among the objects under investigation (Everitt 1993). Cluster analysis allocates cases based on their characteristics, forming clusters or groups (Sierra Bravo 1987). Cluster analysis seeks to discover categories and structures congruent with observations, which lead to the formation of "natural grouping" (Pielou 1984; Uruguay MGAP-DIEA 1983).

Several methods may be used to form the groups, but the most commonly used are the hierarchical cluster techniques. There are two basic methods of hierarchic cluster analysis depending upon how the types or groups are formed: the *agglomerating methods* are those which proceed through a series of successive fusion of individuals into groups, and the *divisive methods*, which separate the individuals successively into finer groups (Everitt 1993)

Hierarchical clustering is based on the mathematical concept of distance, and clusters or groups are formed according to how close or far apart the points considered in the data set are (Solon and Guerrero 1989). Methods for hierarchical clustering differ in the algorithm used for estimating the representative point of the cluster or centroid (single linkage, complete linkage, centroid to centroid, average linkage, Ward's method) and in how the distance is estimated (For instance: Euclidean, Mahalanobis, Ivanovic, Manhatan) (Uruguay MGAP-DIEA 1983; Morgan *et al.* 1996). The result of the hierarchic agglomerating techniques is a tree with complete data assignments at each level known as dendrogram. The problem of the hierarchic techniques is to choose the aggregation level of the groups or rather the number of groups. In the hierarchic techniques one subjective criteria is to choose the maximum value of loss of information that the researcher is prepared to accept (Ferreira 1975; DIEA 1983; Basel *et al.* 1989; Krebs 1989). Therefore, a subjective assessment must be made in order to choose the cut-off or aggregation level; in other words, select the appropriate number of clusters for the purpose of the research[3]. Many different types of group analysis have been developed, and there is not "correct one" or ideal system (Everitt 1993; Uruguay MGAP-DIEA 1983; SPSS 1993).

7.3.4. Discriminant analysis.

Once the FD-MU was classified by cluster analysis, discriminant analysis was used to test group membership for each FD-MU, to determine the variables more strongly associated to each group and to validate the classification. Discriminant analysis is used to estimate the stability of the classification obtained showing the percentage of cases classified incorrectly. Based on the values of selected original variables for cases whose group membership is known, linear combination of the independent variables are formed and are the basis for classifying cases into groups (SPSS 1993). In this case, two canonical discriminant functions were calculated. Thus, information from the multiple independent variables is resumed in a single index trying to obtain the major separation between groups. The linear discriminant functions are those whose coefficients maximise the ratio of between-groups to

[3] *The central paradox of the methods of group analysis is that they are objective and exact methods but that subjective decisions have been taken concerning strategy, standardisation of data, variable and index of similarity* (Krebs 1989).

within-groups sums of squares (SPSS 1993). The effectiveness of the classification obtained was tested on the basis of the percentage of cases classified correctly. Based on the high probability of belonging to each group, three case studies were chosen[4].

7.4. Procedure used for classifying FD-MUs.

In this work, a divisive hierarchical clustering technique based on Ward's algorithm (Everitt 1993) was used, which involved the square of the Euclidean distance for the interval and binary variables, and the Chi-square measure for discrete variables. Ward's algorithm is a method where each case is progressively merged into groups with a minimal increase in each step of an objective function, that is, the sum of the squares of the error (DIEA 1983). The method uses the means of each variable within each cluster and calculates the euclidean distance referred to the cluster means for each case. The distance for all the cases are added. The two clusters producing the smallest increment in the total sum of the squared within cluster distances are merged (SPSS 1993). The software SPSS 6.1 for Windows was used to perform the cluster analysis. Prior to this, factor analysis was used to select the factors from both surveys to be used in the clustering. Using this procedure, it has been possible to use the most relevant information from each data base in order to classify the FD-MUs.

The hierarchic classification dendrogram obtained is presented in Figure 7.1, and

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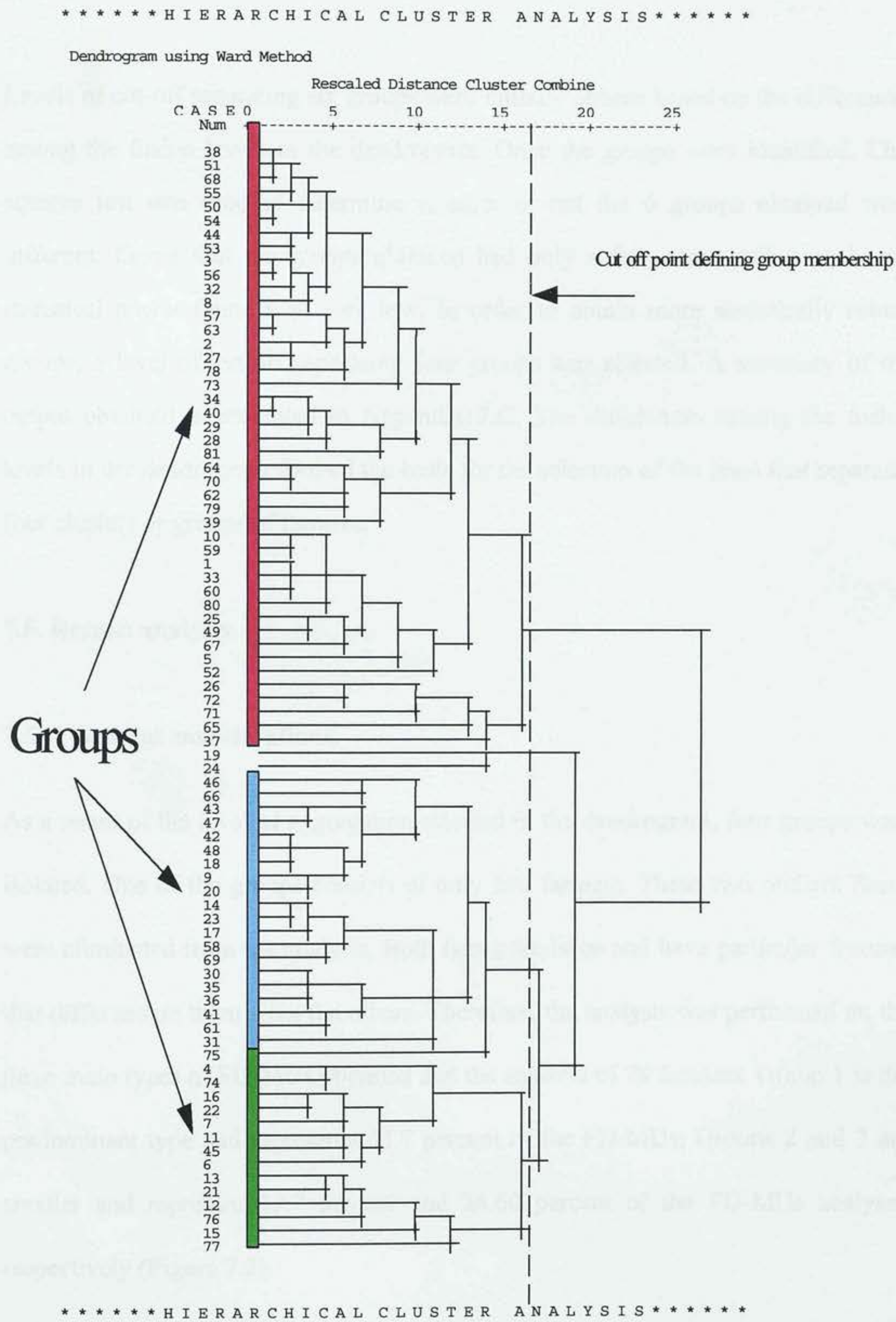
[4] More detailed information about the methodology for case study selection is presented in Chapter 8.

Figure 7.1. Dendrogram obtained using Ward's Method, showing level of cut off selected.



illustrates the divisions made at each successive stage of the cluster analysis (Everitt 1993).

Levels of cut-off separating six groups were initially chosen based on the differences among the fusion levels in the dendrogram. Once the groups were identified, Chi-squares test was used to determine whether or not the 6 groups obtained were different. Given that the groups obtained had only a few cases within each, the statistical power found was very low. In order to obtain more statistically robust groups, a level of cut-off separating four groups was selected. A summary of the output obtained is presented in Appendix 7.C. The differences among the fusion levels in the dendrogram formed the basis for the selection of the level that separates four clusters or groups of farmers.

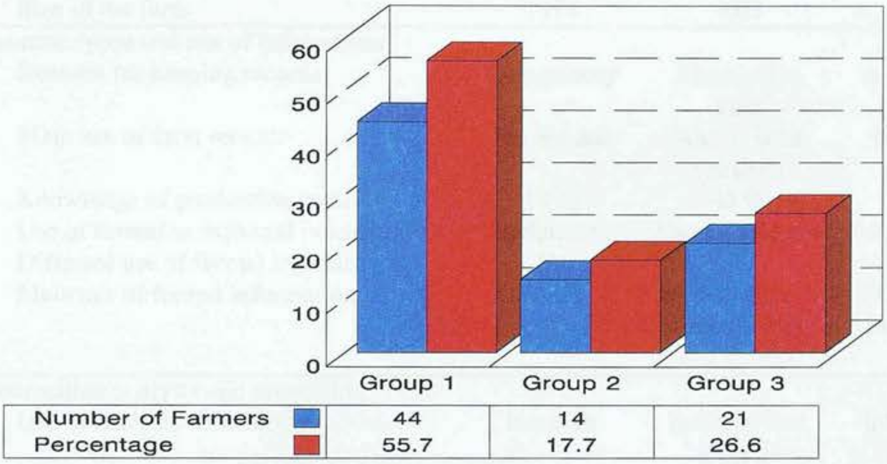
7.5. Results analysis.

7.5.1. General considerations.

As a result of the level of aggregation selected in the dendrogram, four groups were isolated. One of the groups consists of only two farmers. These two outliers farms were eliminated from the analysis. Both farms are large and have particular features that differentiate them from the others. Therefore, the analysis was performed on the three main types of FD-MUs obtained and the answers of 79 farmers. Group 1 is the predominant type and represents 55.7 percent of the FD-MUs; Groups 2 and 3 are smaller and represent 17.7 percent and 26.60 percent of the FD-MUs analysed respectively (Figure 7.2).

In order to analyse the information, one-way analysis of variance and Chi-square analysis were used to test the differences between the selected variables of each group.

Figure 7.2. Number of farmers by group.



7.5.2. FD-MUs Types description

A detailed analysis of results is presented in Appendix 7.A and addendum. In this section, a summary of the most relevant features of the groups will be presented.

In Table 7.3. are presented some of the main significant variables which differentiate the groups and the level of significance.

Table 7. 3. .Main differences among FD-MUs Types, showing levels of significance

Variable[5]	Group 1	Group 2	Group 3	Significance
Farm and household features				
Farmers age	+ 50	+ 50	20-39	*
Youngest child's age	20-39	1-9	1-9	*
Property transfer	Family	Family	Family/ manager	**
Size of the farm	1310	1663	4692	3**/1,2
Sources, types and use of information				
Reasons for keeping records	Compulsory	Manage the farm	Manage the farm	**
Main use of farm records	Do not use	Know farm situation	Other farm activities	*
Knowledge of production costs	14 %	43 %	48 %	**
Use of formal or informal information	Informal	Form./Informal	Form./Informal	**
Different use of formal information	No	Yes	Yes	**
Main use of formal information	No	Planning, Investments and credits	Planning and investments	**
Information analysis and processing				
Use of analysis or intuition	Intuition	Intuition and analysis	Intuition and analysis	*
Own computers	7 %	14 %	48 %	**
Farmers knowledge exchange				
Acquisition of ideas from other farmers	71 %	100 %	76 %	*
Acceptance of ideas by other farmers	54 %	79 %	81 %	*
Actual farm organisation	Family	Family	Family enterprise	**

[5] Education does not show statistically significant differences between the three groups (Appendix, Section 7.1.5; Addendum Table 7.4). Some explanation related to this point, that emerge from the analysis of the quantitative and qualitative data will be expanded in Chapter 9, Section 9.4 Further research considerations.

Table 7.3. Main differences among FD-MUs Types, showing levels of significance (cont.)

Variable	1	2	3	Significance
Frequency of planning activities	Almost never	Almost always	Almost always	**
Period of planning activities	Not formal planning	One year or more	1 to 6 months	**
Main information sources	-SSA & C [6] -Family - Mass Media	- Advisers - Famiy and SSA & C	-SSA & C -Mass Media and Advisers	
Production system orientation				
Main activity in beef cattle production	Cow-calf	Complete cycle	Complete cycle	*
Main activity in sheep production	Complete cycle	Complete cycle	Complete cycle	**
Sheep cattle ratio	5.86	4.35	3.9	1*/2,3
Agroecozone	I	II	I and II	**
Strategy to cope with production bottle neck'	To do nothing	Pasture improvements	Pasture improvements	**
Number of paddocks	6	10	16	1**/2**/3**
Use of electric fence	No	Yes	No	**
Percentage of improved land	1.1 %	7.8 %	4.1 %	**
Use of best pastures to fat animals	64 %	64 %	91 %	*
Main objectives with pastures	Feed animals and maintain natural pasture	Feed animals	Feed animals	**
Animal counting frequency	1 to 2 months	every month	1 month and more	**
Salaried labour needs	Low	Medium	High	**
Attitude to changes				
Interest in farm diversification	No	Yes	Yes	**
Credit use	No	Yes	No	*
Use of agronomic advice	No	Yes	Yes	**
Interest in applying the latest technology	No	Yes	No	**
Farm improvements in recent years	No	Yes	Yes	**
Use of public extension services	No	Yes	No	**
Visits to Research Institutions	No	Yes	No	**
Farm income perception	Acceptable	Bad	Acceptable	*

Based on the means and mode of the information presented, it is possible to depict the main features of the FD-MU Types found with the classification process.

[6] Stoke and station agencies and clerks

• Group 1, "Traditional routine": FD-MUs of this group have adopted a defensive behaviour to changes. They manage, relatively, the smallest farms of the sample which are located mainly in the agroecozone of shallow soils (Appendix 7.A; Section 7.1 and 7.8). Group 1 farmers are mainly over 50 years old, with the youngest child aged between 20 and 39. They gain access to the control of the resources through a family relationship (Appendix 7.A; Section 7.1). The strategy for the farm system it is to establish a high sheep/cattle ratio. A cow-calf enterprise is the main activity in beef production and a complete cycle in sheep production (Appendix 7.A; Section 7.8). The production systems work with low external inputs and investments. Both enterprises require modest levels of capital and are not associated to high risk. Farmers establish the work routines and practices (often inherited) and apply them year after year with only minor changes. They consider there is not much that can be done within the farm to modify the output and the profitability, therefore, economic performance is mainly associated to years of good/bad weather and/or prices. Perhaps the low potential for improvement of these soils and the fact that the technology offered does not provide sufficient advantages, could explain the reluctance of these farmers to adopt new technology and advice and to search for new information (Appendix 7.A; Section 7.9). These farmers tend to preserve the natural grasslands.

Decision making processes are based on intuition (Appendix 7.A; Section 7.2 and 7.3). Therefore, the main inputs for decision making are mainly informal.

Farmers neither develop formal planning to organise their activities nor do they have close control of the production process (Appendix 7.A; Section 7.7). They tend to look more at the external rather than the internal factors to manage their farm, making their decisions based mainly on market changes. Their main sources of information are the stock station agents and clerks, the family and mass media. They are more interested in the production problems of the farm rather than in broader economic issues. One important indicator of this difference is that they are largely ignorant of their production costs. The main objectives are to produce more and provide education for the children (Appendix 7.A; Section 7.10) They are happy to be farmers and they consider their income from the farm is acceptable and, therefore, they are not dissatisfied despite the fact that their farms have the lowest in productivity and therefore in gross income of the three groups (Appendix 7.A; Section 7.14).

• Group 2: "Innovative Sustainable". FD-MUs, of this group are innovative and have adopted a strategy to introduce changes and innovations in order to improve their farms. Farmers of this group are older than 50, but their youngest child age is between 1-9 years old (Appendix 7.A; Section 7.1 and 7.8). They gained access to the control of the resources through a family relationship and own medium size farms located mainly in the agroecozone II, where the best soils are. The production system is orientated towards complete cycle in both beef cattle and sheep production. This group is where the best production indicators are found: the highest percentage of land with improved pastures, and the best cattle and sheep weaning percentage (Appendix 7.A; Section 7.8). Both formal and informal information is used in analytical and intuitive decision processes (Appendix 7.A; Section 7.2 and 7.3). This group is keener on using formal planning and has close control of the production process (Appendix 7.A; Section 7.7). They focus on solving internal problems of the farm, but they are also aware of what is happening in the market. The adviser, the family, as well as stock station agents and clerks are the main sources of information (Appendix 7.A; Section 7.2). Advisers are mainly used to support animal and pasture decisions and investments. This group also maintains and uses formal farm records and is interested in using public extension services and credit and, consequently, are more aware of relevant new techniques.

In order to cope with the production stress, farmers have improved their farms and adopted new technologies (Appendix 7.A; Section 7.9). To this end they search for information within the family but also talk with advisers of the public extension services or go to research stations. They like to show other farmers about what they are doing but they also like to learn from other farmers and advisers (Appendix 7.A; Section 7.5). This group of FD-MU is highly motivated to learn and incorporate new techniques. The main objectives are to produce more, provide education for the children and maximise income. FD-MUs of this group are generally dissatisfied with the income which they obtain from their farm (Appendix 7.A; Section 7.10).

• Group 3: "Entrepreneurial Imitators". On average, the farmers of this group are the youngest and own the largest farms. Access to the control of the resources has been gained through managerial partnership activities, as well as inheritance (Appendix 7.A; Section 7.1 and 7.8). Decisions are based on formal and informal information: formal information is mainly used to support planning and investment decisions (Appendix 7.A; Section 7.2 and 7.3). This group owns the highest number of computers which are used for economic and financial recording and analysis (Appendix 7.A; Section 7.4). However, members of this group do not monitor the production process closely. Public extension services are not widely used but rather they prefer to pay for private advice (Appendix 7.A; Section 7.9). Credit is not important to assist investments because they have adequate personal capital. They are not so interested in the latest technology, but prefer to wait to assess the results on other farms (Appendix 7.A; Section 7.9). A manager is often employed and may perhaps be one of the partners with the responsibility for running the farm.

FD-MUs of this group identify themselves as entrepreneurial and show more obvious interest and determination in acquiring market, economic and financial information (Appendix 7.A; Section 7.6). The main sources of information are stock station agents and clerks, advisers and mass media (Appendix 7.A; Section 7.2). Stock and station agents mainly provide information about markets for agricultural products. Despite this, FD-MUs are also production orientated and they are interested in the economic and financial problems affecting their farms and keep appropriate records. A high percentage of FD-MUs of this group are not dissatisfied with the income obtained from the farm (Appendix 7.A; Section 7.10).

According to the evolutionary theory (Nelson and Winter 1976), there are two main mechanisms of evolution: economic natural selection and adaptive learning. The three FD-MU groups represent the result of different adaptive learning patterns. The rules of behaviour that have provided satisfactory results are memorised and retained while rules that failed are discarded. Rural people's knowledge about old practices and rules are the knowledge that has been acquired in the past. This knowledge is the result of a selection process and will be used until it is considered obsolete. The change is introduced by the farmer's "mutations". According to Vromen (1995) the "mutations" are:

> *the result of search efforts which in turn are enticed by dissatisfactory results of using "old rules"(that so far have yielded satisfactory results)... Rules that are selected in processes of adaptive learning can be said to be replicated...Imitation may be the result of a deliberate attempt to copy the "success formula" of others...or may occur without the imitators even being aware of them. In both cases imitated rules are eventually subjected to the selection test. "The proof of the pudding is in the eating"; only if the imitated rules turn out to do well are they maintained."*

Group 2, the "innovative sustainable", could represent the "mutations". The FD-MUs tend to be dissatisfied with the results obtained from "old rules" and they search for new options, technologies and investments in order to modify the production system.

Group 3, the "entrepreneurial imitators", could correspond to Vromen's (1995) deliberate copiers attempting to imitate some "success formula" tested by FD-MUs in Group 2.

Group 1, the "traditional routine", includes FD-MUs using "old" rules but who have adapted their objectives in order to maintain the old routines.

7.6. Validation of classification

7.6.1. Methodology

Different methods can be used to validate and determine the stability of the classification obtained. DIEA (1983) points out five methods: Homogeneity Index (Kaminsky 1980); Relative Efficiency Index (Van Rijsberjen 1970 cited by Ferreira 1975); Discriminant analysis; Contingency Tables and Kruskal Wallis' Test. According to the same source, the most standard procedure is discriminant analysis.

In this research, to validate the classification obtained, to determine the characteristics that differ amongst the groups and to confirm the group membership of each farmer, discriminant analysis was performed.

Discriminant analysis is a technique applied to classify cases into already known groups based on a set of original variables considered relevant for the study. That is, by using cluster analysis each case was classified as a member of one group. By using discriminant analysis it is possible to test how the group membership obtained by cluster analysis works out in relation to a set of original variables selected to validate the classification process.

One of the advantages of discriminant analysis is that it is not sensitive to the scaling of the original variables (Manly 1988). Using this procedure original variables related to socio-economic, demographic, type and use of information for decision's support, use of analysis and planning, type of farm organisation, communication with other framers, main management practices used, attitude to changes and perceptual level of satisfaction with the income obtained were used to validate the classification. The selection of the variables to include in the discriminant analysis was based on the discriminant power of the variable and the relevance of the variable to the study. Variables that have shown significant differences in the Chi-square test of association among the three groups, and variables related to the use of information not previously used in the classificatory process were used to perform the discriminant analysis (Williams 1994).

Table 7.4 presents the discriminant functions of the variables analysed and the level of association between them. The variables with the largest absolute correlation between each variable and each of the discriminant functions are indicated with an asterisk. The level of significance of the variables and the trend is also presented.

The process starts by analysing the differences between groups by considering the univariate statistics. The significance of these differences is tested calculating one-way analysis of variance, to maximise the F ratio for each variable considered. A pooled within groups correlation matrix is later obtained by averaging the separate correlation matrices for all groups and then computing the correlation matrix. The pooled within groups correlation between discriminant variables and canonical discriminant functions, as well as the positive or negative direction and the level of association, are also presented in Table 7.4.

Function 1 has the major proportion of sum of squares of between-groups to within-groups. Function 2 is non-correlated to Function 1 and has the next major proportion. The two functions are all non-correlated to each other and maximise the proportion of the sums of squares of between-groups to within groups, subject to the constraint of being non-correlated (SPSS 1993).

Table 7.4. Discriminant functions showing discriminant function coefficients, level of significance and trend (Pooled within-groups correlation between discriminant variables and canonical discriminant functions. Variables ordered by size of correlation within function).

Variable	Function 1	Function 2	Significance[7]	Trend
Total wool production	.32712*	.16362	**	+
Number of paddocks	.32268*	.05735	**	+
Total cattle	.29043*	.10310	**	+
Farm size	.26521*	.14578	**	+
Number of salaried labour	.23199*	.06875	**	+
Total heads of sheep	.22750*	.15422	**	+
Own a computer	-.22288*	-.09864	**	-
Farm organisation	.21313*	.06375	**	+
Interest in farm diversification	-.20236*	.16442	**	-
Production costs' knowledge	-.17415*	.06424	**	-
Different use of formal and informal information	.16984*	-.13849	**	+
Main activity in sheep production	.16667*	.15316	**	+
Age of youngest child	-.16666*	-.01714	**	-
Age of the farmer	-12767*	-.10322	**	-
Use of analysis or intuition to support decisions	.12643*	-.05365	*	+
Acceptance of their ideas by other farmers	-.12493*	.05272	*	-
Farmer formal education level	.11880*	-.07558	*	+
Use of formal or informal information	-.11846*	.00801	*	-
Main activity in beef cattle	.11816*	.08713	*	+
Use of best pasture for finishing	-11414*	-.07550	*	-
Use of the latest technology	-.18976	.29856*	**	-
Strategy to cope with production bottle neck	-.26071	.29336*	**	-
Percentage of pasture improvements	.18447	-.28669*	**	-
Period of planning goals	.11417	-.23198*	**	-
Agroecozone	.15564	.22314*	**	+
Frequency of planning goals	-.14932	.21378*	**	+
Farm improvements in recent years	-.16541	.19303*	**	-
Satisfaction with farm income	-.00279	-.18466*	**	-
Counting animal frequency	-.04757	.17763*	**	-
Attitude to crossbreeding	-.07010	-.16609*	**	-
Acquisition of ideas from other farmers	-.05072	.15846*	*	-
Use of credit	.05458	.15754*	*	-
Type of off-farm activity	.02842	.15081*	NS	-
Activities considered in diversification	.13303	-.13803*	**	-
Have an off-farm activity	.02667	-.11369*	NS	-
Percentage of cropped land	.08900	-.09843*	NS	+
Use of advice	-.09014	.09163*	NS	-
Use of electric fence	.01961	.08331*	NS	-
Property transfer	.01447	-.08213*	NS	-
Number of children	-.01693	-.05044*	NS	-
Grain winter feeding	.01642	.04739*	NS	-
Percentage of off-farm income	-.03812	-.04560*	NS	+
Percentage of off-farm work	-.03595	-.04172*	NS	+
Main reasons to keep records	.02697	.03429*	NS	+

* Denotes largest absolute correlations between each variable and any discriminant function.

[7] Wilkis' Lambda (U-statistic) and univariate F-ratio.

The canonical discriminant function was evaluated at the centroid of the groups. Table 7.5, shows the means used to perform the analysis.

Table 7.5. Groups centroids (means).

	Function 1	Function 2
Group 1	-1.73575	0.47723
Group 2	0.3342	-3.21416
Group 3	3.08119	1.14287

The output information obtained through the classification done from the discriminant functions and which shows each of the farmers classified within each group, is presented in Appendix 7.D. The most probable group membership for a farmer, based on the discriminant analysis, is presented in the column labelled Highest Group. Those farmers classified erroneously are indicated with an asterisk. Information from all the 79 farmers was processed without weighing the variables (Appendix 7.D). No farmers were excluded for missing codes, out-of-range group codes, or missing discriminant variables.

The Classification Table showing the number of farmers correctly and incorrectly classified is presented in Table 7.6.

Table 7.6. Classification Table, showing classification results.

Actual group	Nr. of farmers	Predicted group membership		
		1	2	3
Group 1	44	44	0	0
		100.0%	0.0%	0.0%
Group 2	14	0	14	0
		0.0%	100.0%	0.0%
Group 3	21	2	0	19
		9.5%	0.0%	90.5%

According to the information presented, the discriminant functions achieved a classification accuracy of 97.5 percent. The results suggest that good discrimination has been achieved among the three clusters. To test the null hypothesis that means of the considered functions are the same in the three groups, the value of Wilkis' Lambda and its associated Chi-square value, the degrees of freedom and the significance level are presented in Table 7.7.

Table 7.7. Statistical indicators associated to each discriminant function.

Function	Eigen-value	Percen-tage of Variance	Cum Percen-tage	Canonical Correlation	After Function	Wilkis' Lambda	Chi-square	Degrees of freedom	Signifi-cance
	--	--	--	--	0	0.05358	159.49	88	0.0000
1*	4.4955	65.23	65.23	0.90045	1	0.29448	66.629	43	0.0119
2*	2.3958	34.77	100.00	0.840	--	--	--	--	--

Eigenvalues associated to a discriminant function (eigenvector) expressed as a percentage of the total sum of eigenvectors , gives a measure of the importance of the associated function. Wilkis' Lambda is an indicator of the discriminant capacity of information within the independent variable data set. Larger Wilkis' Lambda indicates that less amount of discriminant information remains unexplained (Newman *et al.* 1990). Since the observed significance level is less than 0.00005, the null hypothesis that the means of both functions are equal in the three farmer's population can be rejected. That is to say that the classification obtained through the group analysis using 44 relevant variables was successfully validated using discriminant analysis.

Once the model was successfully validated using 44 variables, discriminant analysis was used to explore the trade-off between the reduction in the number of variables used to classify farmers and the accuracy of that classification. A commonly used algorithm as an exploratory tool for identifying variables with high discriminant power is known as the stepwise selection (SPSS 1993). The procedure consists of including the first variable with the largest correlation and then evaluating the other variables with the largest acceptable criterion step by step. Therefore, the reduction process was done based on the selection of the most highly correlated variables of each function. The discriminant functions obtained and the accuracy of the classification are shown in Tables 7.8 and 7.9.

Table 7.8. Discriminant functions showing discriminant function coefficients, level of significance and trend, when reducing variables from 44 to 7.

Variable	Function 1	Function 2	Significance[8]	Trend
Total wool production	0.49881	0.37486	**	+
Number of paddocks	0.48734	0.10107	**	+
Farm size	0.40500	0.33781	**-	+
Percentage of pasture improvements	0.26417	-0.76727	**	-
Interest on farm diversification	-0.29658	0.45409	**	-
Use of credit	0.08911	0.39889	**	-
Use of the latest technology	-0.17694	0.35544	**	-

* Denotes largest absolute correlation between each variable and any discriminant function.

Table 7.9. Classification Table, showing classification results reducing the number of variables from 44 to 7.

Actual group	Nr. of farmers	Predicted group membership 1	2	3
Group 1	44	37 84.1%	5 11.4%	2 4.5%
Group 2	14	2 14.3%	11 78.6%	1 7.1%
Group 3	21	2 9.5%	3 14.3%	16 76.2%

By the reduction in the number of variables, the discriminant functions achieved a classificatory accuracy of 81.0 percent. The results suggest that it is still possible to achieve reasonably good discrimination among the three clusters and that the value of Wilkis' Lambda and its associated Chi-square value are still significant (Table 7.10).

[8] Wilkis' Lambda (U-statistic) and univariate F-ratio.

Table 7.10. Statistical indicators associated to discriminant function, when the number of variables is reduced from 44 to 7.

Function	Eigen-value	Percen-tage of Variance	Cum Percen-tage	Canonical Correlation	After Function	Wilkis' Lambda	Chi-square	Degrees of freedom	Signifi-cance
	--	--	--	--	0	0.246283	102.994	12	0.0000
1*	1.9886	84.72	84.72	0.8157	1	0.736037	22.526	5	0.0004
2*	0.3586	15.28	100.00	0.5138	--	--	--	--	--

The information obtained suggests that an alternative and reasonably robust method based mainly on the use of a few highly discriminant variables to classify farmers into "recommendations domains" could be developed. Therefore, by selecting information from a reduced number of sources, cost and time could be substantially reduced and results could be obtained faster. These early findings need to be confirmed with further research.

7.6.2. Graphical representation of the groups

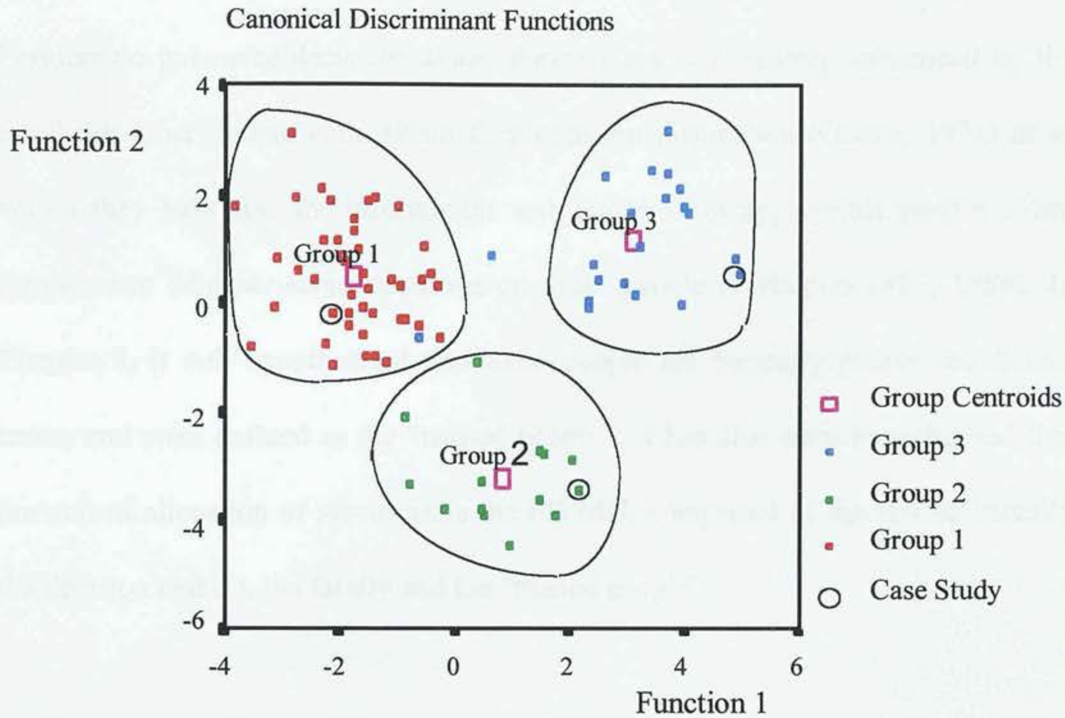
Once the classification obtained was validated for this study based on i) the high probability of being satisfactorily classified, and ii) farmers' relevant features; one farmer out of each group was selected as an in-depth case to be studied.

In Figure 7.3, a classification chart is presented which shows the situation in which each function contributes to FD-MUs groups' separation and, separated within each group, the selected case studies. As shown in Table 7.7, Functions 1 and 2 explain 65.2 and 34.8 percent of the data set variance, respectively.

Figure 7.3 represent the geometric space defined by the discriminant functions using their discriminant coefficients as coordinates for all the FD-MUs analysed. The variables more strongly associated to Function 1 and the level of significance are presented in Table 7.4.

According to this information highest values in Function 1 are associated to FD-MUs with: highest wool production, greater number of paddocks, higher number of cattle, and who have the largest farms, more salaried labour, a higher number of sheep, more inclination to use computers, an entrepreneurial perception of their farms, an interest in farm diversification, more inclination to know their production costs, visited research institutions, carry out complete cycle in sheep production; with young farmers who have the youngest child, who make use of analysis to support decisions, who consider that other farmers accept their ideas, who have a high formal education level, who use formal and informal information, who are orientated towards finishing farms and seed stock farms in beef cattle production and who consider that the best pasture needs to be used to fatten animals.

Figure 7.3. Canonical discriminant functions and groups of farmers obtained.



In the case of Function 2, lower values are associated to FD-MUs characterised by the following attributes: interest in applying the latest technology; interest in improving their farms to cope with production bottle necks; having the highest percentage of land with improved pastures; formally planning their activities for a period of one year; mainly located on other basaltic soils; almost always plan their activities; have made improvements on their farms; show dissatisfaction with their farm income; count their animals every month; present interest in cross-breeding; acquire knowledge from other farmers and are planning to increase the hectares of improved pastures.

7.7. Farming decision making unit description

Farmers do not make decisions alone. Farmers are significantly influenced by the family or other people with whom they compare themselves (Gasson 1971) or to whom they look for, for information and advice from appropriate people. Also, farmers can delegate some decisions on other people (Errington 1985, 1986). In Chapter 3, it was hypothesised that these people are basically people the farmer trusts, and were defined as the "trusted people". It has also been hypothesised that the unit of allocation of resources is the FD-MU, comprised of the farmer (usually the decision maker), the family and the "trusted people".

To determine who these people are, during the survey the farmers were asked which people were involved in the decision making process with regard to a particular topic. Farmers[9] were also asked to ponder the importance of each person in the decision making process according to six different types of key decisions. The analysis of the quantitative and qualitative information obtained on this particular topic, is presented in the following sections.

7.7.1. Decision to farm under the current system

The first type of decision analysed was that which concerned the people who intervene in the decision of managing the current system (Figure 7.4.1). In all

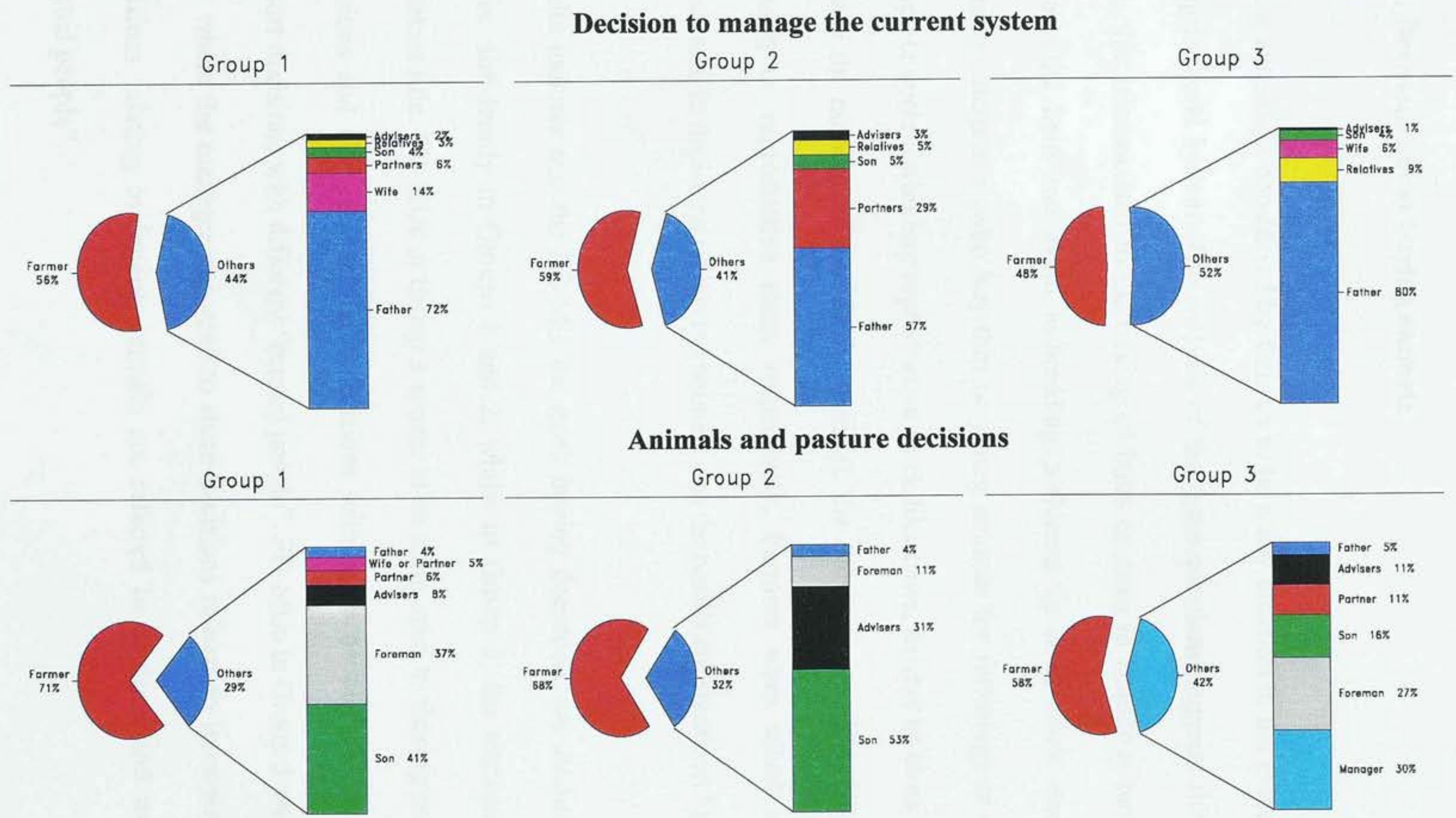
[9] This person was self identified. Therefore, the analysis is based on farmers perrception of the decision making process.

groups, the farmer is the kernel of the FD-MU, taking less than 50 percent of the responsibility only in Group 3. Looking at the other trusted people, the link between generations appears very strong in all groups. The relation between the farmer and his father is highly dependent on whether the older generation managed the same agricultural production system as the present one. Therefore, the information suggests that FD-MUs scope for this particular type of decision, is beyond the limits of one generation. The high relevance of the elder father in this decision suggests that not only did he transfer the land, but he is also one of the most relevant figures in the current managing system. The farming system represents the last stage in the evolution of knowledge, beliefs, objectives and strategies developed by the elder father when he was the kernel of the FD-MU. A farming system was probably transferred where the components (number of beef cattle, number of sheep, number of paddocks, percentage of improved pastures, percentage of crop land, etc.), the organisation (main work routines), management practices (animal, pastures, crops, etc.), economic and financial conditions (capital availability, assets, debts, etc.), knowledge and management rules, relationship with the local community and labour knowledge, skills, routines and traditions were fully incorporated. Based on this information it is possible to assume that the FD-MU is not static but evolving, and that by the influence of each generation in the current farming system, it gradually changes. These results seem to endorse the findings of Errington and Tranter (1991) working in the UK.

7.7.2. Animal and pasture management decisions

Farmers were also asked about the involvement of other people in decisions relating to animal and pasture management.(Figure 7.4.1). The important point to highlight relates to how much of the decision making is shared with other people; who these people are and what their function is. The information suggests that FD-MUs in Group 3 are more open because they share decisions with more people. A further point is that FD-MUs in Group 2 share decisions with the manager, advisers and also

Figure 7.4.1. Farmer and "trusted people" involved in decision making by type of decision and group membership



It appears that foremen, advisers and managers act mainly in an advisory role, giving advisory rules, information or implementing the decisions.

7.7.3. Decisions about buying animals.

Buying animals is considered by farmers to be a key decision in the management of the agricultural system. The analysis of the open-questions suggests that, in some cases, this is associated to the buying of bulls or rams to introduce new genes to improve the herd and avoid in-breeding problems. In other cases, such as with finishing enterprises (who buy thin or young animals for fattening) or others like 'complete cycle' (who buy reproductive stock like cows, heifers or ewes in order to increase the number of animals for mating), the decisions are either related to the fattening or reproductive rates, respectively. Farmers were asked about who participated in decisions on buying animals and the results are shown in Figure 7.4.2

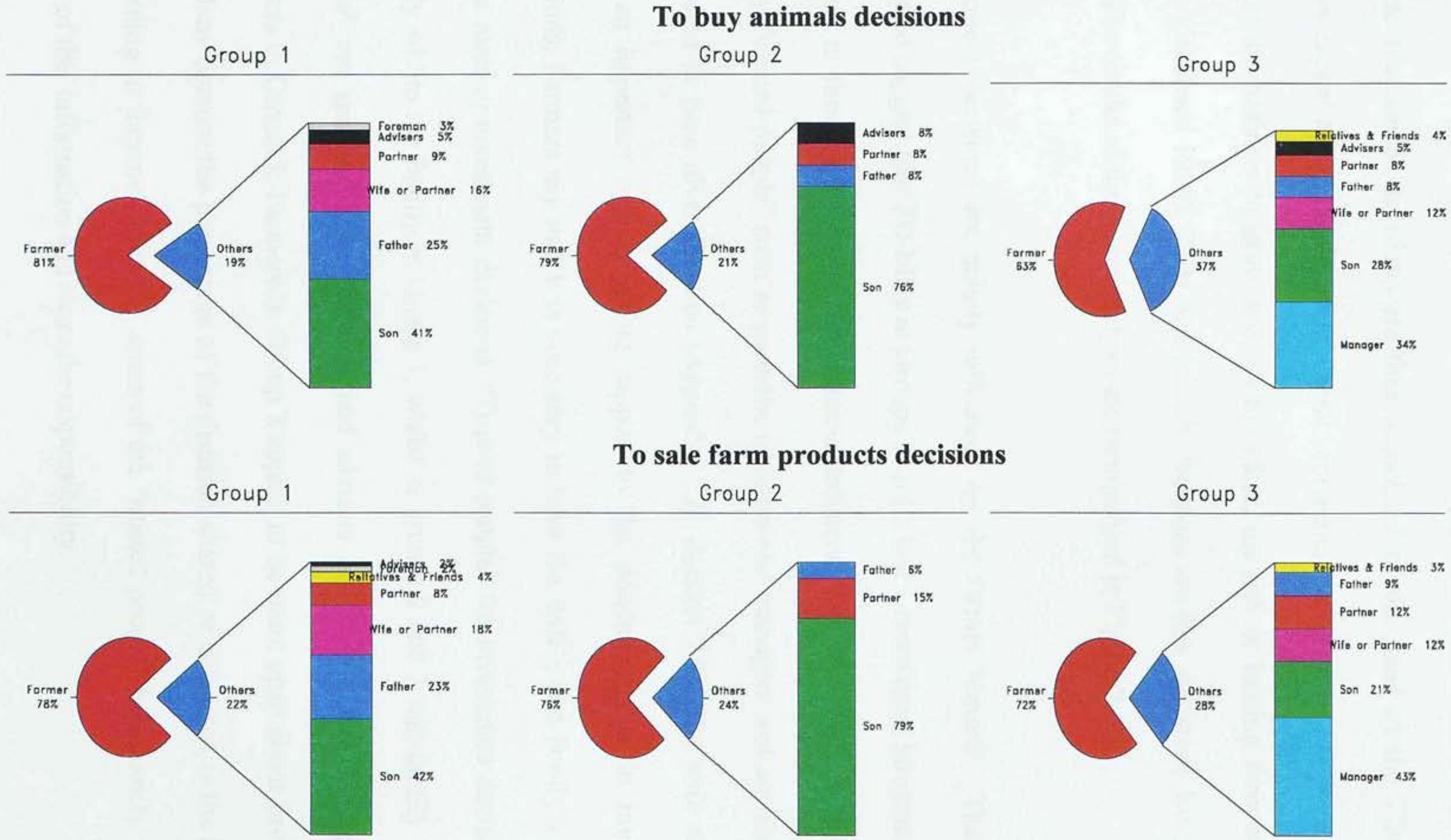
Results indicate that the FD-MU for stock buying decisions, are discussed mainly within the family in Groups 1 and 2, whilst in Group 3, the manager plays an important role. FD-MUs in Group 3 appear to be more open to sharing or delegating decisions and also tend to share decisions with more people. The three groups support decisions with different "trusted people". FD-MUs in Group 3 were the only ones where the manager appeared to share decisions related to livestock purchase. Decisions relating to buying animals are referred to advisers and managers as "trusted people".

7.7.4. Decisions about sale of farm products.

Farmers consider the sale of products as one of the key decisions. In Uruguay, the main product of sheep production is wool. Mutton is considered a by-product and is usually used for household consumption. Farmers generally sell all the wool produced during the year at a particular date in the year. Considering the marked seasonal variation of prices, selling wool is a risky decision. In the case of beef cattle production, farmers sell at more than one point of the year. These differences are one of the reasons for preferring a mixed beef and sheep production system farm type, where income and products are diversified. The different people involved in each FD-MU group are described in Figure 7.4.2.

The Figures suggest that the family in Groups 1 and 2 is mostly involved in selling decisions, while in Group 3, these decisions are trusted more to the manager. Similar to previous decisions analysed, these are predominantly influenced by the farmer himself. "Trusted people" appear to be involved, to some extent, in selling and buying decisions. Farmers in Group 3 appear to be more open to the input of others and were the only group where the manager appears to be sharing or having been delegated with decisions which are of relevance.

Figure 7.4.2. Farmer and "trusted people" involved in decision making by type of decision and group membership



7.7.5. Investment decisions

Many technological changes at farm level imply investments in the production system. Investment decisions are then associated to the need of the FD-MU to acquire capital against their assets. Credit represents, on one side, the possibility of helping the business to grow and, on the other, the risk of loosing farm assets or goods (Jacobsen 1990). Thus investments decisions are key decisions for the FD-MU. The results of the group analysis are summarised in Figure 7.4.3.

Investment decisions are mainly influenced by the farmer himself . The results presented suggest that FD-MUs in Groups 2 and 3 had a more open integration. The farmers in these groups share investment decisions, look for support from non-family "trusted people" such as partners, advisers and managers and are also more interested in farm diversification (Appendix 7.A; Section 7.9). The wife seems to play an important role in giving support to the decision maker in investment decisions. Farmers say that it is necessary to have the wife's and family's support before making investment decisions. "Trusted people" for investment decisions are largely within the family in Group 1, whilst in groups 2 and 3 non-family "trusted people" are also involved: partners and advisers in Group 2 and managers and advisers in Group 3. Farmers in Group 2 appear to be more open about investment decisions because the percentage of the decision shared or delegated is the highest. According to farmers' answers, some of the "trusted people" here mostly validate some of the information and share the responsibility.

7.7.6. Economic and financial day to day decisions.

According to farmers, economic and financial day to day decisions are "time eaters" but are considered key decisions, in the sense of cash flow management and the time required to perform the tasks.

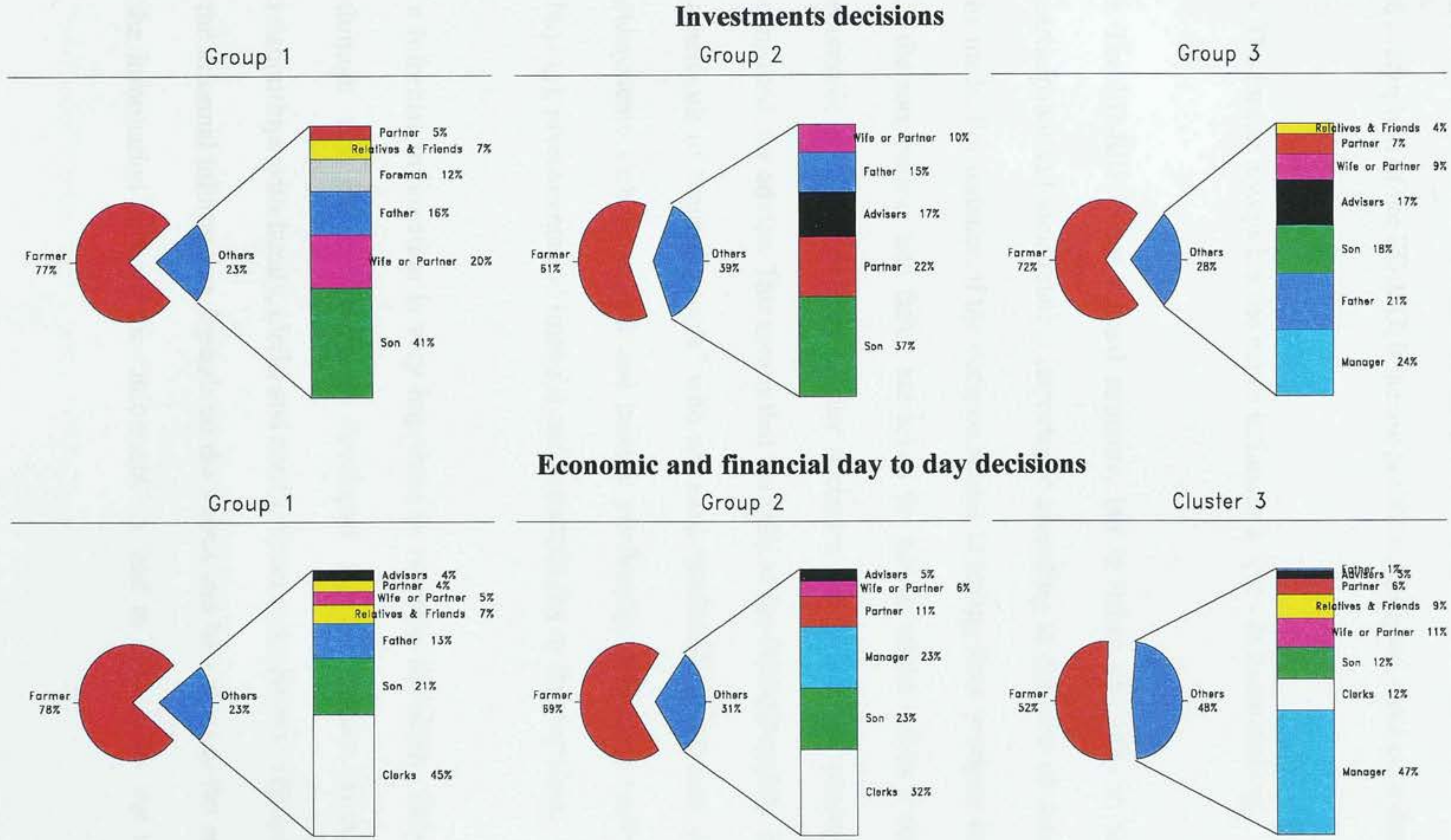
In order to know the features of these decisions, farmers were asked about the people who were involved in these decisions and the results are summarised in Figure 7.4.3.

Economic and financial day to day decisions are mostly taken by the farmer. However, in Groups 1 and 2 they are mainly delegated on clerks, the son and the father having some relevance. This is the only type of decision in which FD-MUs in Group 1 considerably take into account the support of non-family people such as clerks. The explanation could be in some of the farmers' answers:

> "*We do not have an alternative. We are forced to delegate the task to a clerk or a manager, because we do not know anything about how and when to pay taxes, or what the last laws for salaried labour payment are, ...*"

As in other decisions, FD-MUs in Group 3 enhance delegating a major portion of the shared decisions to the manager.

Figure 7.4.3. Farmer and "trusted people" involved in decision making by type of decision and group membership



7.8. Summary of analysis.

Having presented the main features of the groups, the validation of the classification and the description of the FD-MU, it is now possible to suggest some considerations.

- The farmer always has the major influence in farm decision making.

- The FD-MU is not a fixed structure, but is rather adaptable in terms of participants and their relative importance according to the type of decision to be made. For instance, if the decision relates to selling farm products in Group 2, the son, partner and father are asked for advice whilst, when it relates to economic and financial day to day decisions, the clerks and managers are consulted for advice. This means that the DSS of the FD-MU mainly involves a network of "trusted people" who are used specifically to support different subsystems such as animal and pasture production, marketing (selling and buying), investments and financial and economic day to day decisions.

- Informal information is very important in reaching decisions. This comes through the informal network developed by the farmer through his relationships with family, clerks and rural officers and advisers. The quality of the informal information depends on the source and how close to the origin of the information network the "informant" is, and as well as on the level of experience of the informant for assimilating and communicating the information.

• Formal information is mainly used to support planning and investment decisions and as a complementary source of information.

• Decisions about selling and buying stock are of more concern to the immediate "trusted family people".

• Observed results of the three groups of farmers appear to be reinforced by findings on other research studies carried out in New Zealand by Fairweather and Keating (1990), and in the UK by Perkin and Rehman (1994). These studies try to identify groups according to farmer goals and objectives. The first three groups found were labelled "the dedicated producer", "the flexible strategist" and "the environmentalist" and the second three groups found were, "monetary", "life style" and "independence". Although this study is focused on a broader understanding of FD-MUs' behaviour, it is possible to find some similarities among the groups obtained. The "dedicated producer" and the "monetary" are broadly similar to Group 2, "the innovative sustainable". The "flexible strategist" and the "life style" would be similar to Group 3, "the entrepreneurial imitators". And finally, "the environmentalist" and "independence" have some similitude with FD-MUs in Group 1, the "traditional routine". This information suggests that the three research studies, two focused on farmers' objectives and goals and this one on farmers' behaviour, identify groups of farmers with some common characteristics in the three different countries, but with different working environment variables. Future research will need to identify the similarities between farmer populations in these three countries and account for the underlying reasons.

• The behaviour of the FD-MU is the result of the interaction between the "trusted people" (including the "trusted family people") and the farmer.

• FD-MUs comprise a decision support system that varies according to the type of decision analysed, adapting the components to the problem analysed.

• The three groups of FD-MUs considered use the advice of different "trusted people" to support the same decisions or, in other words, have different decision support systems.

Using all the information supplied by the three groups, the six types of decisions considered and farmers' interview considerations it is possible to delineate a new hypothesis.

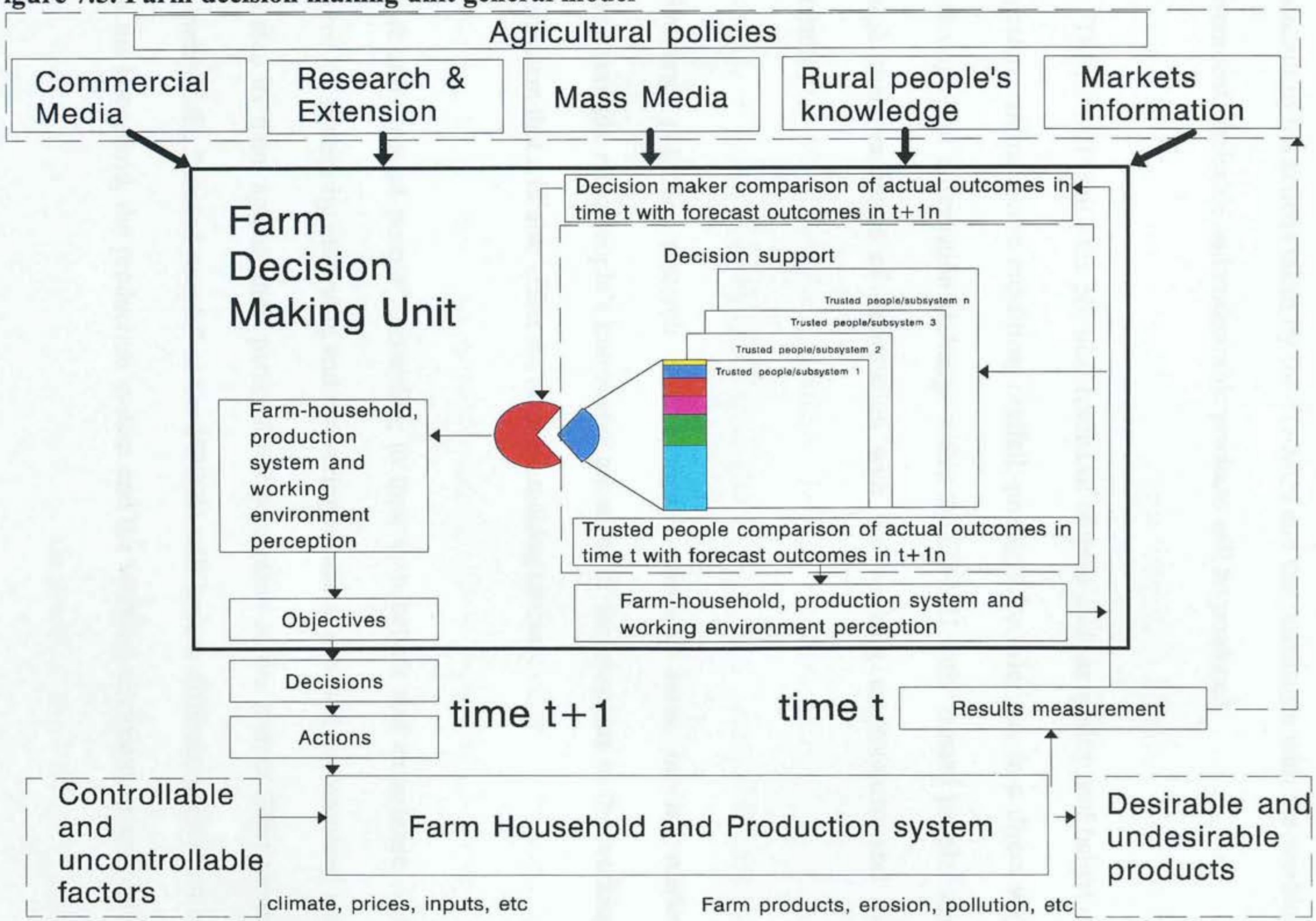
Apparently, "trusted people" have different informative functions: some act as experts gathering data from different sources in order to process and analyse it (usually in a subjective, intuitive way) and give the results to the decision maker in an easily understandable and relevant form. These "trusted people" who accumulate and process information from different sources providing the decision maker with the result of their "analysis" in the form of advisory rules could be defined as "information digestors". Other "trusted people" just validate some ideas and encourage the decision makers in concepts or with information that the decision maker already has. Such people could be defined as "sounding boards". With the information available up to this point, it is only possible to hypothesise that farm decision making is mainly supported by the action of "trusted people" acting as "information digestors" and "sounding boards".

7.9. Farm Decision Making Unit Decision Support.

Based on the information presented it is possible to start depicting some general model of the FD-MU (Figure 7.5). The first point is related to the family and the "trusted people". The decision maker as the kernel of the FD-MU will share with, delegate unto or ask for advice from "trusted people".

In the case of the family not all the members of the family participate in the FD-MU. It appears that only the "trusted family people" are involved in farm decision making. Therefore, it is possible to hypothesise that the relationship that connects the members of the FD-MU are the levels of trust within the household and without the household.

Figure 7.5. Farm decision making unit general model



Secondly, the production system is continually changing both under the influence of management decisions and under the influence of external variables, some of them uncontrollable to the FD-MU's control.

As a result of the actions taken by the FD-MUs and the interaction with the working environment, desirable and undesirable products will be produced.

The FD-MU will notice the physical results of outputs such as quality and height of the pasture, animal score condition, rainfall, products for sale, etc. in a direct way and through oral information exchange within the FD-MU with "trusted people" and through their exchange of information with the working environment and the community.

Agricultural policies, research and extension actions, mass media, market information and rural people's knowledge are some of the elements in the working environment that will also affect the decision making process.

Farmer and "trusted people", according to their own beliefs and experience, will monitor the system by observing and measuring results which will be compared and evaluated by them against their personalised perception of the system. That means that each of the "trusted people" in the FD-MU will have a different perception of what the household, the production system and the working environment are really like, and what decisions must be made in order to control the production system so as to satisfy their objectives.

These perceptions and objectives will be the result of the interacting of the farmer's and the different "trusted people's " personal values and beliefs. Therefore, decisions at farm level can only be understood taking into consideration the objectives and perceptions of the "trusted people" and those of the decision maker who constitute the FD-MU. That means that the best decision for the FD-MU could turn out not to be the better decision for the decision maker or conversely.

These mechanisms of control start when the decision maker, in his attempt to achieve some objectives, makes a decision. Then he compares the results measured at time t, with some standard results that he perceives should be achieved at time t+1. A similar process is developed by the "trusted people". Therefore, the perception about what is happening at time t and what should be happening at time t+1 as far as the farmer and the "trusted people" are concerned, could be different. Consequently, the decision maker needs to decide what actions to take in the production system, in order to avoid conflicts with the "trusted people" and obtain the best results for the objectives of the FD-MU as a unit.

This process is similar to a feed-back self-teaching mechanism developed by cybernetic systems to solve complex tasks. Complex tasks are the result of self-teaching mechanisms in which, in seeking the achievement of some final objective, changes are produced in the methods for reaching and for setting several intermediate goals (The New Encyclopaedia Britannica 1995). During this process of search and "trial and error", the FD-MU recalls, "digests"(processing and analysing) and stores new information which, after being validated several times, is transformed into rules and knowledge to manage the system. At this point, it is possible to hypothesise that it is in this feed-back process where the decision maker "validates trusted people". When some "trusted people" who initially helped the decision maker as a sounding board to validate information get several satisfactory answers obtained in several trials, this "sounding board" will be considered as an "information digestor" by the decision maker. This is another new hypothesis to be tested with the in-depth study.

In fact, this is a typical dynamic feed-back control mechanism where the controller is the FD-MU. Therefore, the control of the production system evolves in a feed-back cybernetic[10] mechanism of self-learning, carried out by the FD-MUs in a feed-back trial and error process. In other words, the FD-MUs gain knowledge and experience and evolve by adaptive learning.

On the same line as Errington (1985), the management control function comprises 5 steps:

[10] There are two main views of cybernetics, one more narrow, that defines cybernetic as the science of control of complex systems, and another more broader interpretation that includes not only control, but all forms of infromatio processing (The New Encyclopaedia Britannica 1995).

- setting standards
- gathering information on current performance
- comparing the two
- diagnosing reasons for discrepancy
- taking any necessary corrective action.

The first four functions are developed in some way by the decision maker and the "trusted people", but the last is only taken by the decision maker or somebody to whom he delegates the authority to make the decision (Errington 1985; 1986). Apparently, it is in the diagnosing and analysing of reasons for discrepancy between actual and future results through "digesting information" or validating information such as "sounding boards" where the decision support of "trusted people" is crucial.

According to the information presented, FD-MUs in Group 1 will be responsive mainly to rural people's knowledge and market information. FD-MUs in Group 2, will be responsive mainly to new technology and the use of research, extension, and credit services, and FD-MUs in Group 3 will first be responsive to markets and then also to the gradual incorporation of new technology following observation of other farmers.

Based on the statistical analysis of the information, it has been possible to describe and classify farmers and to have a general understanding of the decision making process at farm level. Although clear differences among groups of farmers were detected, it is not possible to go further into the understanding of the micro-dynamics of the process to depict the FD-MU models for the three groups studied. It can be found that the decision support for the FD-MU comes mainly from the "trusted people".

7.10. Summary of considerations.

The results presented in this chapter suggest certain points for consideration:

1. Findings show that the hypothesis supported by the TOT model that all FD-MUs respond in the same way to policy measures, that farmers are perfectly informed and that their behaviour is aimed at optimising the use of resources and maximising income, can all be rejected.

2. The classification obtained using cluster analysis demonstrates that it is possible to classify groups of farmers based on the main features of the FD-MUs. These groups can be used as recommendation domains to better target agricultural policies and research and extension actions. Results suggest that extension and research policies based on the TOT model are relevant to some of the presented groups of FD-MUs.

3. Results suggest that farmers do not make decisions in isolation: they share and look for advice from "trusted people". The FD-MU comprises the farmer, the family and the "trusted people". Therefore, decisions are not taken only considering

farmers' objectives. Decisions at farm level are the result of the interaction between the farmer, the family and the "trusted people" regarding objectives, perception and the evaluation of the production system and the working environment.

4. The groups of FD-MUs found represent populations with different behaviour routines and rules. These are the results of the evolving interaction within the FD-MU, the production system and the environment. Results presented suggest that the evolutionary approach provides a good conceptual framework to offer an improved understanding of decision making at farm level.

5) Based on the analysis of the information it was possible to depict a general model of FD-MU. The model suggests that decision making at farm level can only be understood taking into consideration the objectives and perceptions of the farmer, the family and other "trusted people".

The results obtained with the classification do not provide a good explanation on the dynamic and inner mechanisms of the FD-MUs. It was possible to identify that decisions at farm level are mainly supported by trusted people; and formulate two new hypothesis about the informative role of the "trusted people". It is necessary then to gather some more relevant information in order to test the new hypothesis relating to the different informative functions of "trusted people" acting as "information digestors" and "sounding boards" and to determine the different information flows within the FD-MU with the working environment. Also, it is necessary to determine the dynamic of the process; how people become "trusted" and how, within the "trusted people", some are considered by the decision maker as a "sounding board" and others as "information digestors". The methodology selected in order to explore in depth the dynamic of the decision support at farm level was the case study.

Chapter 8

Case Studies Evolution and Analysis

8.1. Introduction

This chapter is devoted to an in-depth explanation of the FD-MUs internal information flows and dynamic mechanisms utilised to support decision making from an evolutionary perspective. In Chapter 7, a general model of the FD-MU was depicted on the basis of the analysis of the survey and the classification analysis performed in Chapter 6. The results have shown that the FD-MU is a complex unit comprised of the decision maker (usually the farmer) and the "trusted people". Despite that, the different "roles" of the "trusted people" and the formal and informal "recall" of information utilised by the FD-MU in order to make a decision is not clear. Also, it was possible to determine three clearly different "Types" of FD-MU's behaviour that are the result of different "rules" and information search routines. However, the difference between the information flows and mechanisms for supporting decisions is not clear. Results suggest that the "innovative sustainable" will search for information about technology mainly from advisers and public extension agencies; the "entrepreneurial imitators" will search for it from managers and private advisers, while the "traditional routine farmer" will depend more on rural people's knowledge (Appendix 7.A; Section 7.2).

In Figure 7.5, the decision support in the formulated model is a "black box" integrated by "trusted people" whose dynamic and informative function needs to be clarified. How and why it works is not clear. Related to this topic, two new hypotheses were delineated in Chapter 7. One proposed that "trusted people" have two different informative functions: i) acting as "information digestors" processing and analysing information from different sources and ii) acting as "sounding boards" either validating information that the decision maker already has or through a supportive action encouraging the decision maker.

The other hypothesis is related to the process through which some "trusted people" become "information digestors" and others become "sounding boards".

Here the discussion is structured in order to obtain a deeper understanding of the FD-MU. The FD-MU will make decisions that will directly affect two units: the farm household and the farm-as-a-firm. In order to understand these inner mechanisms used by the FD-MU, information about the family and the farm history, its evolution, the pattern of household consumption, property's transfer, production efficiency, farmer's management ability, the sources of information, the main "rules" and "information routines" used to manage and monitoring the production system, need to be acquired.

8.2. The essential dynamics of the FD-MU

In order to examine the FD-MU in a dynamic, integrated and evolutionary context, an integrated system's approach was used. The case studies will be focused on the analysis of how the FD-MUs respond under some common critical internal and external events that force the system to move into atypical conditions. The subject of this research relates of critical incidents approach, to how these events, which throw the system out of balance, are adapted by the FD-MU in order to find solutions in order to maintain their objectives.

The objective of this work it is to better understand the main elements behind the decision making process, in order to establish the information and mechanisms used by the FD-MU to support decisions. In this way, it will be possible to understand the rules and key elements of the process that can lead to change. According to Dossi, Pavit and Soete, (cited by Dossi 1988) it is important to differentiate among factors that induce, stimulate or constrain technical change and the results of the changes themselves. Rosenberg (cited by Dossi 1988) suggests that the mechanisms that induce change may involve:

- technological bottlenecks;
- scarcities or abundance of critical inputs.
- changes in growth demand .
- change in relative prices

To analyse which FD-MU mechanisms are adopted to support decisions and information search when it is necessary to respond to some internal or external change, the case study will focus the analysis on four situations that are common to all the three cases analysed:

- Property transfer mechanism and farm size evolution. Looking at property transfer, it is possible to analyse the early stages of the FD-MU and what the main decisions were at the beginning of the farming business. Having past information on farm evolution will provide a better framework to understand the reasons for present decisions. The analysis of the evolution of the FD-MU and the farm will explain the process of information exchange between the FD-MU and the working environment.

- Management during a drought. The severest drought of this century in Uruguay was experienced during 1989 until middle 1990. All farmers were faced with totally unusual conditions that forced them to make decisions. The highest damage resulted in the basaltic area. In-depth qualitative and quantitative data should provide useful information to assist understanding better how the different FD-MUs responded and behaved when they came up against a "big" significant external change.

- Strategy to cope with seasonal production bottlenecks. Uruguay is characterised for having four definite marked seasons. Farmers in the basaltic region usually face seasonal conditions like cold winters and hot and dry summers. In ELPS, more than 85 percent of the feed for animals is provided by natural pasture. These seasonal variations affect the production system and present a constraint that farmers have to face up to every year. By defining the strategy, information and knowledge developed and used by the different FD-MUs analysed, it is possible to understand better how to provide relevant support for coping with these regular changes.

• Loans requirements and use. Under normal conditions, some farmers are prone to borrow and others will be unlikely to do so. By clarifying the different perceptions and attitudes towards borrowing money analysis of the three FD-MUs provides useful information about farmers' attitudes to credit policies.

Focusing on these common situations, this research attempts to establish the information flows and search routines adopted by the FD-MU in order to support decision making . A priori, it may be anticipated that the three selected cases' (which belong to three different "types" of FD-MUs), behaviour will respond to "changes" in a different way. The need to study decision making under a dynamic conception is not new.

> *"Remove dynamic changes and you will have taken away the need for the most significant production decisions"..."We conclude that what we know as the firm is the product of dynamic conditions and it must be examined in terms of a dynamic setting. We will therefore proceed into an economy in which there is change and disequilibrium. We will look*

upon the firm like the biologist does upon the cell. We will make it our smallest basic action unit in studying production"(Schultz 1939).

Therefore, in order to understand the dynamic of the decision making process it is necessary to choose a method that can provide relevant information to explain the inner mechanisms of the process. This method must also provide information about the process of innovation and tacit knowledge learned internally by the FD-MU in the management of irregular and discontinuous changes (Wiggins 1996).

8.3. Methodology

8.3.1. General considerations

The methodology selected to study the detailed mechanisms of the decision making process was in-depth case study. Case study is a methodology developed with the aim of gathering information in order to gain a closer understanding of the problem under study. There is no standard methodology for performing a case study as many factors are discovered during the study (Howard and MacMillan 1991). Case study methods have been used in social science in order to study a range of problems such as: i) the process of adaptation to external pressures (Gafsi and Brossier 1996) ii) development planning using a system learning approach (Macadam *et al.* 1995), iii) determine critical factors for farmers success (Howard and MacMillan 1991), iv) farmers strategic planning (Brunåker 1989), v) farm growth dynamics (Fergusson 1984) vi) effects of agricultural changes (Hannibal and Sriskandarajah 1996), vii) teaching farm management (Ravenscroft and Wiggins 1990) and viii) evaluation of environmental policy (Skerrat 1995).

The advantage of the case study methodology is that it permits intense analysis (Gafsi and Brossier 1996). It is possible to study the dynamics of change looking at how qualitative and quantitative features of a past decision affect present decisions. Founded on a close relationship between the interviewee and the interviewer, the method enables the researcher to identify and communicate with other people involved in the FD-MU and observe the production system directly.

Case studies are a good tool to suggest and evaluate critical success factors in farm management. The main constraint of the approaches is that the information can not be statistically representative (Howard and MacMillan 1991). According to Patton (1980, 1986) case studies are a methodology useful to understand a problem in great depth or when it is possible to identify cases with useful information to the study's purpose.

In this research, the in-depth study's main objectives are:

- to understand the inner dynamics of the FD-MU in an evolutionary framework.

• to understand the adaptation process of the FD-MU focusing on decision support.

• to understand the different informative functions of "trusted people".

The results of three case studies with farmers of the Basaltic area of Uruguay will be presented.

8.3.2. Methodological procedures

Case selection

In the majority of the in-depth studies, case selection is mostly based on subjective analysis. Two criteria are frequently used: i) one is that the researcher selects the cases on the base of the previous knowledge of the problem under study, acting as an "expert" and ii) the criterion of "convenience" based on the possibilities of access to the source of data (Ferreira, Eulacio and Dent 1996). Clearly, in both situations it is not possible to evaluate the precision and confidence of the information and also, in many cases, the population to which the cases belong to is not clearly defined. Patton (1986) presents fifteen different strategies for selecting case studies and concludes that the logic of each strategy follows a particular purpose and that the important thing is to select information-rich cases which can provide relevant information for the study. He defines information-rich cases as those from which it is possible to learn and gather important information or knowledge about the key elements of the study. However, it is recommended to mix more than one strategy to select the cases. The general methodological procedures were presented in Chapter 6 (Section 6.2).

As can be seen, the cases were selected after a classification process was performed and validated (Figure 8.1). Therefore, case selection has been supported by the statistical procedures of cluster and discriminant analysis, in order to characterise clearly the population from where the cases are selected. A more detailed explanation about cluster and discriminant analysis was presented in Chapters 6 and 7.

As a result of the classification, three different groups of FD-MUs were identified and analysed (Figure 8.1). One farmer in each group was selected taking into account:

• statistical analysis based on the high probability of the case belonging to a group defined by discriminant analysis.

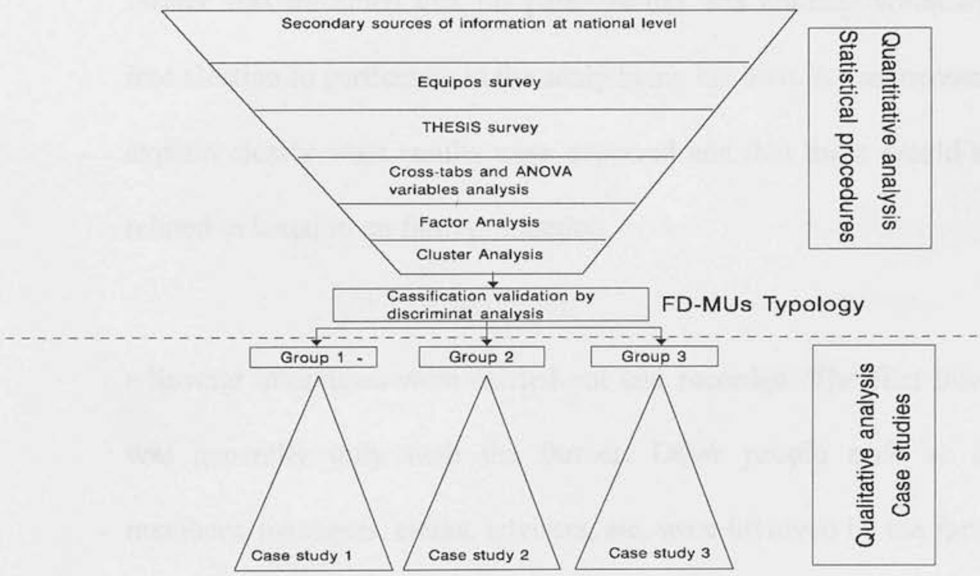
• convenience criterion, selecting a farmer that would be co-operative and open to provide relevant information for the study.

• The possibility of locating critical factors that have allowed them to grow (Howard and MacMillan 1991).

These criteria were based on information acquired during the survey permitting the identification of FD-MUs that have high probabilities of belonging to one of the groups and also to a farm which had the ability of growing in size and stock.

As presented, the methodology's aim is to use the advantages of quantitative and qualitative analysis and to develop a "hybrid" methodology where analysis and synthesis can be combined to improve the understanding of the FD-MUs.

Figure 8.1. Case study selection, showing different methodological steps.



In this way, the information from the analysis of the case studies can be used to test the "conceptual model" developed in Chapter 7.

Interview

Not all farmers like to provide detailed information about what they are doing; it requires for a degree of confidence to be established between the farmer and the interviewer. In order to achieve this confidence, the case study was developed in three main steps:

- First, an introductory interview was carried out in order to present and explain to the farmers the main objectives of the study and why he was selected for the in-depth study. An explanation about the most important subjects of interest of the study was also presented to the farmers. Each farmer was informed that his participation was entirely voluntary, the free election to participate in the study being his own. It was necessary to explain clearly what results were expected and that these would not be related to taxation on farm production.

- Several interviews were carried-out and recorded. The first interview was generally only with the farmer. Other people such as family members, managers, clerks, advisers, etc. were involved by the farmer in further interviews. In general, it was the farmer who decided to look for the support of these other people in order to explain some particular subjects.

  The style of the interview was semi-structured and semi-directive (Robson 1993), in the sense that the prime concern was to understand the interviewee's perception of the question asked. The reason for selecting this strategy was i) to provide a general structure that could help in organising the interview in areas of interest given the complex and vast amount of issues involved, ii) to avoid interviewer bias and follow the interviewee's rationale. To obtain the information, the interview was structured on "big" subjects or areas of interest. The main areas considered were i) farm-family evolution, ii) farm-family objectives evolution, iii) animal husbandry and pasture management rules evolution. iii) farm organisation and facilities evolution iv) main information, knowledge, and indicators used to monitor and control the production system v) information used and people consulted for support on strategic, tactical and operational decisions.

• All the interviews were recorded. After each interview, the notes taken were checked with the information recorded. In some cases, a brief summary of the interview was made and presented to the farmer in order to check numbers and facts.

• Quantitative information related to number of animals, technical coefficients and economic results were collected over a period of seven years for physical data (1989-1995) and five years (1990-1994) for economic data. This information will be presented in Appendix 8. With regard to the evolution of the farm structure, the period considered was longer and varied according to the case considered (Figures 8.2, 8.3 and 8.4). On the basis of the information gathered, the evolution of the three cases can be compared and the effects produced by changes in the production system can be explored.

• The fieldwork was carried out between March to July 1995.

8.3.3. Case studies selection process validation

In order to explore if the case selected was broadly representative of the FD-MU "types" described in Chapter 7, information from six years back on physical and five on economic results were taken mainly from farmers' records. Through this procedure, it was possible to: i) compare the evolution of their respective farms, ii) measure the consequences of FD-MU's response to changes in their techno-economic production system indicators and iii) to validate conceptually the procedure used to select the cases. That is, to verify whether the cases selected are or not fairly representative of the general behaviour described for the three FD-MU "types" presented in Chapter 7. The results obtained are described in Appendix 8. The comparative analysis among "types" and "cases" suggests that the cases behave mainly on line with what was expected from the analysis of the FD-MU "types". This findings permit to suggest that the cases are broadly representative of the groups from which they were obtained.

8.4. Summary of cases results

Because the main interest is to establish comparisons between the three "types" of FD-MU analysed, the results in each Section will be presented for all three cases.

8.4.1. Farm-FD-MU evolution

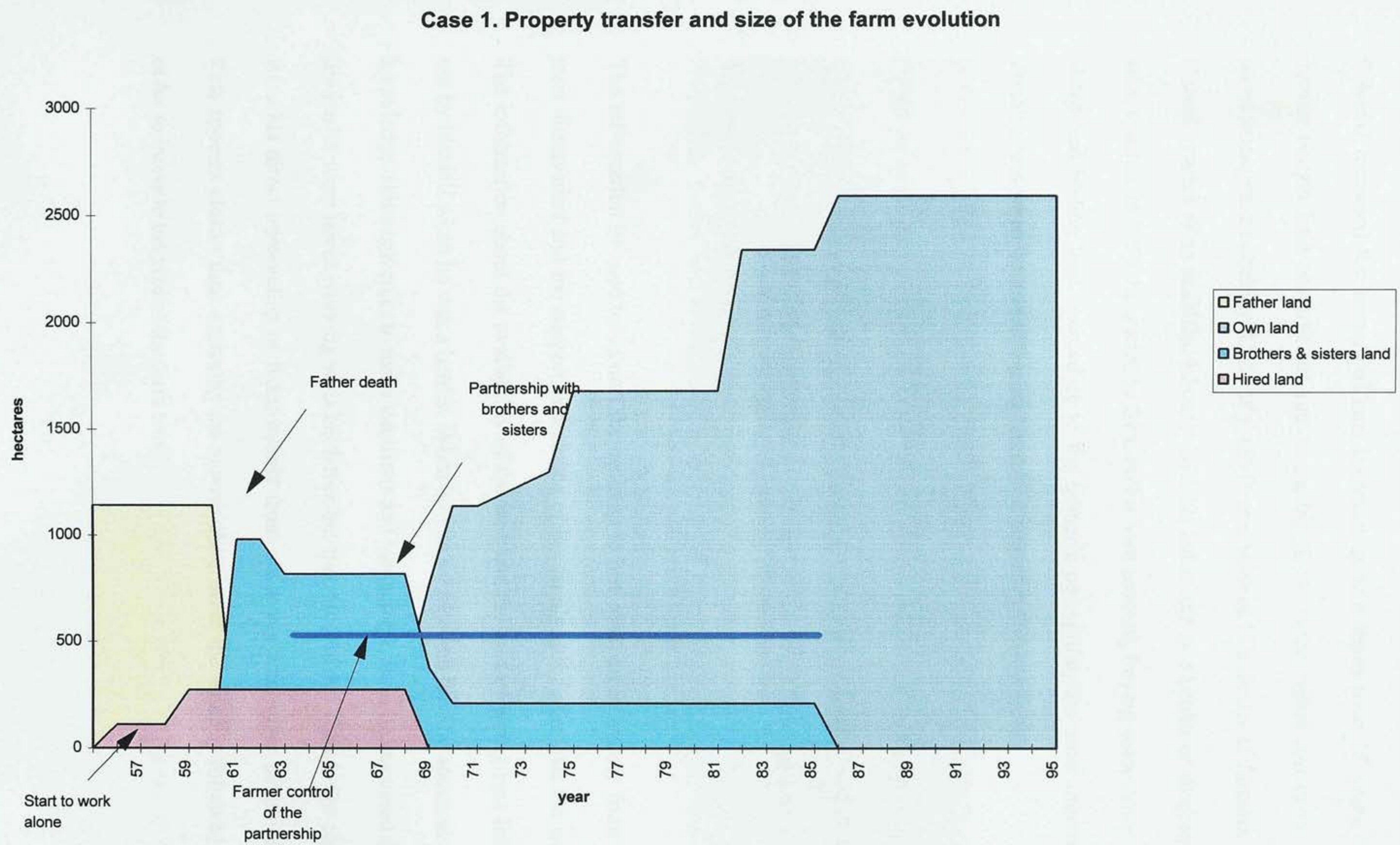
The analysis of the farm FD-MU evolution provides information about how the FD-MU had evolved and how the control of the FD-MU had affected the development of the production system. In this analysis, it is possible to see the whole picture of evolution of the farm and the link between different strategic decisions which explain the present farm-FD-MU situation. Taking the perspective of time, it is possible to understand more clearly the present information routines and behaviour adopted by the three cases. In some part of this dynamic evolution, the FD-MU will make decisions that will prioritise objectives of the family and household and in others the production system. All quotations with grey shadow in this chapter are direct transcripts from the tape recordings made at the time of the interview.

Case 1

Farm size evolution

Case 1 belongs to the "Traditional routine farmers". The variable used to analyse the farm FD-MU evolution was the size of the farm. Figure 8.2, presents the main

Figure 8.2. Case 1. Property transfer and size of the farm evolution



features of property transfer and farm size over time. Over the period considered, the FD-MU increased the amount of land inherited in 15.6 times over 35 years. The farmer bought land on three separate farms but in the same region and under the same management strategy. Currently, the farmer belongs to a family of farmers. He started to work as an unskilled labourer with his father and as a herder or cowboy on others farms. In 1956, he started to farm on his own account, buying some cows and sheep and leasing land. According to the farmer's perception, the most important decision was when he started leasing land.

" *I will never forget that moment in my life. My golden dream was to start producing on my own on land hired by me. I can tell you exactly the livestock I had at that moment: 31 cows, 260 sheep and 6 horses. I hired 110 hectares. This was one of the happiest moments in my life.* "

The information he used to support the decision to hire land, came mainly from his own observation and the support and advice of his family; his father and his wife. The information about the availability of the land and the cost of hiring was found out by himself when he was a herder. When he was asked about how he acquired the knowledge, skills and rules to make decisions and manage the farm, he answered that the basics were learnt working with his father but that most of his knowledge came from his direct observation of facts; mainly from observing what other people did. This appears clearer than analysing the answer about what the strategy followed in order to increase the size of the farm was.

" When you want to increase your capital and you do not have more than your own work, you always need to start buying heifers, because it is always cheaper than buying any other animal category, and a heifer gives you the possibility of having calves and increase the number of animals. Each time I went to a cattle auction market working as a herder, I would observe the prices and I used to buy some heifers myself.... I remember that at that time I was working for a big farmer and I went to the auction market to herd his animals. He used to buy bullocks for finishing in his farm. In ten years he lost all his capital; then I knew that finishing cattle you can obtain more money but it is also more risky. "

From this comment it is possible to extract some considerations about the sources of information used for supporting decisions, and how observing trial and error in others' decisions starts developing some assumptions that, once validated, are transformed into knowledge and encapsulated later in a rule.The work he had as a herder provided him with the opportunity of going frequently to the local auction markets. In this way, he started to communicate with other farmers and to observe that heifers is a category of beef cattle that is usually cheaper than others. This information was then tested in different local auction markets and validated with other farmers' or friends' he found at the auction market ("sounding boards") and against his own experience, acting as an "information digestor". Then this new information is associated to previous local knowledge and information he "recalls" related to the attributes of the heifers category that he already had. That is, "a fertile heifer can produce 4 or 5 calves over their productive life". Therefore, if the objective is to increase the number of animals, a good alternative is to buy heifers. This association between these two different sources of informal information is "digested" by the farmer and transformed into knowledge. But in order to make decisions this knowledge needed to be encapsulated in some simpler and more understandable form. This knowledge was then transformed into an heuristic rule that arose mainly as the product of observation and communication in the local working environment and from conditions where he lived. Once the rule was tested, a routine process started, and the rule was used in his own local conditions until satisfactory results were obtained.

He increased the number of animals and land hired until the death of his father in 1960. The father owned 1142 hectares and there were 7 brothers and sisters: he inherited 163 hectares. In 1962, he made a partnership with brothers and sisters and the management of the whole farm was delegated on him. The blue line in Figure 8.2 represents the period when the farmer was in control of the partnership with his brothers and sisters. The brother and sisters worked in the city and the profitability of their 163 hectares of the ELPS was not of great interest to them.

"The thing was that my brother- in- law offered me his land and I bought and paid it on time. Then all of them wanted to sell their land to me, because they knew I would pay and that they could trust me"

Subsequently all partners sold their land to him. His sister was a partner until 1985 when she sold the land to him. Looking at his comment it is possible to suggest that he becomes the "trusted people" of other decision makers as his brothers and sisters and that that was an opportunity to increase his farm size without too much pressure. In this case, the input of formal education and urban "modern" way of life is low given that the farmer did not finish the second year of high school and that between 1956 and 1978 he was living on the farm and did not travel to the city more than 6 times a year. Rural traditions, culture and beliefs are the basis of his perception of his family, farm and objectives development. Another information considered important to him was that he got married in 1953, and he had a son in 1956. He also had a 2 - year old older daughter but to him the important fact was when he had a son. The daughter is a teacher and lives in the city and his son grew up working with him; but he delegated the management of one of the farms in 1975.

FD-MU evolution

Many issues arise related to the farm and the FD-MU evolution. The first thing that appears clear is the intergenerational link over the period analysed. The present farmer buys the same land that his father had. He learnt working him and by his own observation how to manage the farm, the advantages and disadvantages of each paddock, where to buy and sell farm inputs and farm products. Most of the beliefs, traditions and cultural values and main objectives were also learnt in this local working environment were he lives and grew-up. In a way, he developed the set of possible farm and family objectives that could be achieved. It is also interesting to observe how from a family of 7 brothers and sisters, he was the only one that adopted his father profession. The other is that growing-up mainly on the farm region, he does not acquire the "modern way of life pattern of consumption". On the basis of his beliefs and traditions he adopts a very low pattern of consumption and standard of life for the family. The main survival needs are covered with farm products. An indicator of that is the standard of life of his son who is now 37 years old and who manages one of his father's farms, is not too different if compared to the standard of life of the foreman. As his father, he was educated up to the second year of high school in formal education.

It is possible to identify four main periods in the evolution of the FD-MU. As has been pointed out by Nalson (cited by Gasson 1979) the family household is changing over time passing, and this changes will be associated to changes in number of people, needs, and resources available. Looking at the FD-MU it can be added that over time passing not only changes in the family take place, but also in the farm and the "trusted people" involved in decision making. That implies that FD-MU objectives that are the results of the decision maker and "trusted people" relationship, will also change over time, because the needs, resources and opportunities also change over time.

In the first period, the FD-MU appears to be comprised mainly of the farmer's family: his family, his father, and his wife. The father acted as "information digestor" helping him about what to do, and the wife mainly acting as a "sounding board" supporting her husband decisions. In the second period, having a partnership with his brothers and sisters the FD-MU becomes more complex. The farmer must discuss with his brothers and sister about the strategy to follow and most of them participate in a direct or indirect way in the FD-MU. According to him, it was an inefficient and stressful period, because too many people were involved. The third period was when he started to work alone and the fourth is the beginning of the transition of the control to the next generation. It is interesting that in this type of FD-MU, farming is mainly an activity for males and the wife cooks, washes and takes care of children. Then there is a clear division between the roles and who makes decisions on the farm. The FD-MU, in the period analysed, followed the pattern of the family cycle.

The FD-MU responsible for the farm's activities is clearly identifiable in the household. The male head of the family is typically the decision-maker. In this case also, the basic FD-MU is extended to include married children and their families. The farmer, head of the family, still continues to make the major decisions and controls the family and the farm. The FD-MU considers equally domestic, production and financial and economic activities. His son is now 37, is married and manages one of the farms, but he does not receive a salary for that.

" He does not receive a salary, but that is fair, because he is working in his future land. When I feel that he needs something, I give it to him as a present. In fact, my first old lorry that I used to travel between the farm and the city in, I gave it to him.

Also, each year when we brand the animals, I give him some for himself. He now has some capital."

It is possible then to appreciate more clearly the strong intergenerational links in this type of FD-MU and the dependence of the whole household on the decisions of the farmer.

In order to provide information about the main reasons behind the decision to buy land, the farmer was asked about what the main objectives that have lead him to his current situation were.

" *A very important event was when my son was born in 1956. I started to see my family as the same cycle I observe in animals. Birth, growth, life and death. Then, I knew that I needed to accumulate in order to give something to my son. Therefore, my objective was just to grow, buying animals, hiring or buying land, and taking out just the minimum to cover family expenses....I made capital grow in the same way I make a fire. You need to start little by little not putting too much wood or big logs on at the beginning, but once your flames start to grow, then you can start putting more wood in ...That is if, you take money from the farm at the beginning you will never accumulate* "

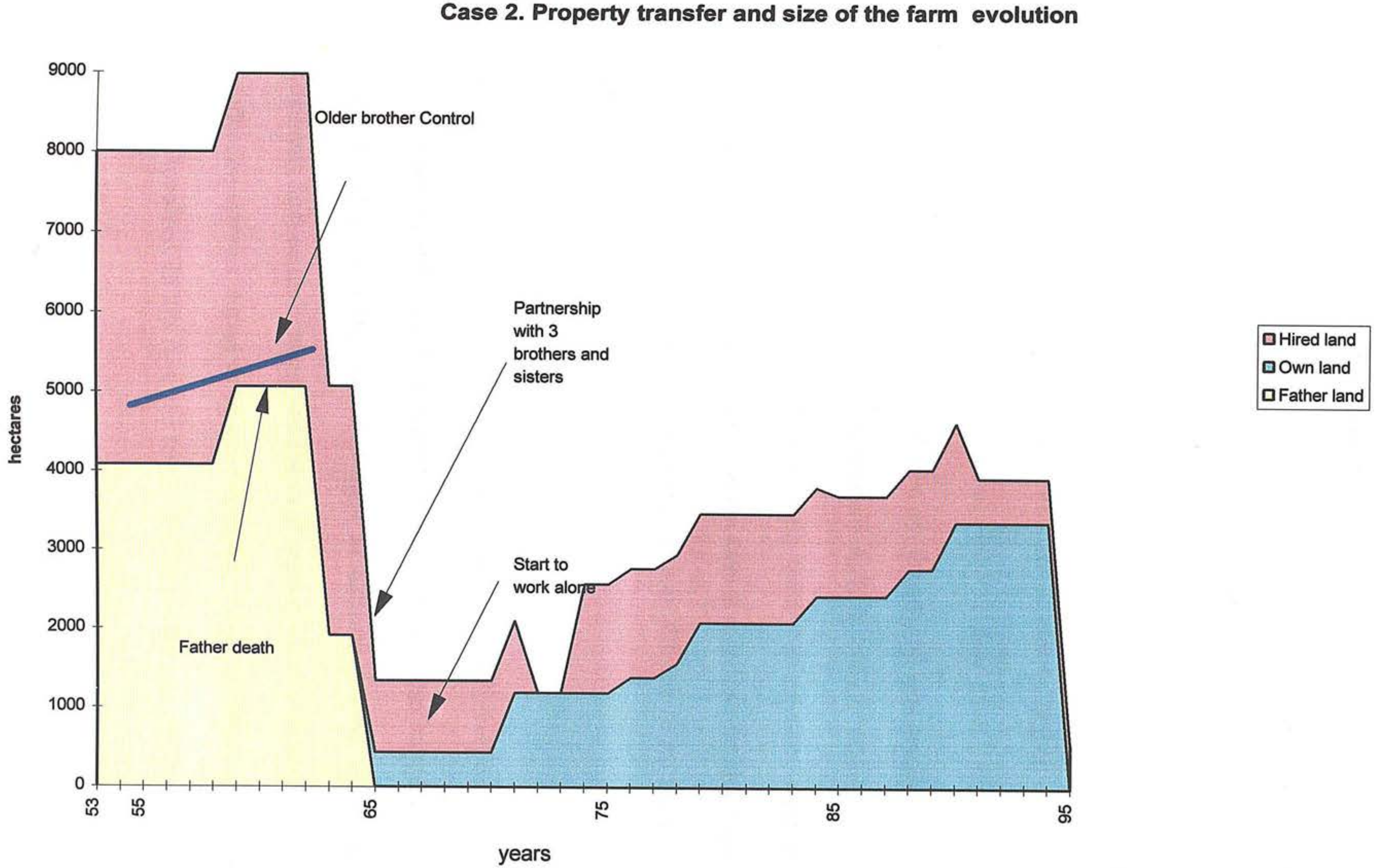
It is important to observe the analogous mental models used by the farmer in order to build up some rules. At first, he cited the cycle of live and death in animals and then, his experience in making a fire. Based on the first analogy he clarified the main objective of the farm which is to increase the capital in order to satisfy a family objective such as the transfer of land to his son. In order to have clear objectives, indicators of achievements are also encapsulated into simple rules of evaluation. The main objective is to grow and the indicators of growth are the number of animals in stock, kilograms of wool produced, number of animals sold, number of cows and ewes and hectares owned or hired. In the second analogy he defines the strategy to follow in order to achieve this objective. That is, by increasing the number of sheep and cows in stock he also increased the possibility of having more animals in the future. Then the information suggests that most of the rules used arise mainly from a strong capacity to "observe" and develop analogies, based on the facts that occur in the local community were he lives. "Trusted people" are mainly considered as "sounding boards" and he is reluctant to delegate tasks on others. What is also relevant is that the knowledge is encapsulated into very clear and simple rules, very easy to understand in his own perception. Therefore, the main "information digestor" in this case is the farmer himself and the information comes mainly from facts and events he has "carefully observed" in his local community. The acquisition of a strong capacity to "observe" and develop "rules" based on his own experience is the response of this type of farmer to changes. Based on this strong capacity to observe reality, he builds mental decision-support systems adapted to each subsystem. In this case information and "rules" in order to manage beef cattle, sheep and pasture with the main objective of increasing the scale of production and not productivity.

Case 2

Farm size evolution

Case 2 belongs to the group of the "innovative sustainable farmers". Figure 8.3 shows the main features of the property transfer and evolution of the size of the farm. As in the first case, the farmer belongs to a family of farmers. He is aged 56 and was the youngest of a family of 9 brothers and sisters. In this case, his father died in 1959 when he was 20. Because his father started to have health problems, the older brother took control of the farm. When his father died, the farmer of Case 2 was studying at a poly-technical agricultural school. He finished his studies in 1963 and started to work with his brothers and sisters, but because he was the youngest, his weight in the decision making process was very low. In 1965, aged 27, he decide to start to farm by himself the 429 hectares he inherited and 777 hectares which he was able to rent. He increased the capital of the land he inherited 7.8 times in 30 years. It is interesting to point-out that the farmer owned two different farms; one in the basaltic region and one in the sandy soils region.

Figure 8.3. Case 2. Property transfer and size of the farm evolution



The main reason for him to make this decision was based on his father's experience. He learnt that the production cycle of pastures in sandy soils is complementary to the cycle of production in the basaltic area. That is to say that during the summer, pasture production on basaltic soils decreases and pasture in sandy soils reach a peak of production. This empirical evidence originated from the rural people's knowledge and has been now scientifically proven (Olmos 1992)

FD-MU evolution

The pattern of consumption of this FD-MU is clearly higher compared to the consumption pattern of Case 1, not only because they have a higher standard of living, indicated by the quality of the house, the car and van, but also because of the conditions and availability of installations such as corrals, fences, the quality of water for animals, etc. to implement farm tasks. Nevertheless, they are not too urban-oriented, given that the house on the farm is more comfortable than the house in the city, indicating that the farmer and his son still live at the farm most of the time.

In this case, the evolution of the FD-MU started with his father, older brothers, and some relatives. When he developed the partnership with his brothers and sisters he was part of the FD-MU but his weight in decision making was small. In the beginning he used his brothers and sisters to support his decisions but later, when the production systems started to be more complex, it was necessary get other "trusted people" involved. In this case, the farmer had an adviser and accountant and clerk to keep the farm records. The financial and economic information is mainly "digested" by the accountant and the clerk. An important point is that the office not only provides "digested" information about his farm, but due to the fact that the accountant and the clerk are involved with a lot of other farmers, a wide range of digested information becomes available apart from that from his own farm.

"We grew up in the farm and we learnt how to work looking at my father and exchanging ideas with my older brothers and sisters. We are all friends, and I started to work on my own in order to start having my own experience but, for each important decision, I consult my older brothers. Not only to receive their advice, but also to receive their support".

In this case, the base of knowledge and skills were also learned on the farm observing what his father, older brothers and farm labour did. This was mainly a source of rural people's knowledge. The older brothers act as "information digestors" and "sounding boards" providing advice in some cases and, in others, validating information the farmer already had. When he got married, his wife started to act as a "sounding board" encouraging him with the decisions but also as an "information digestor" receiving and processing all the information about the household and giving back to him only the results of her considerations. That becomes clear in the following comment:

"We were living on the farm, but when my daughter started high school, my wife decided that the best decision was s to buy a house in the city and move part of the family there. My son was working with me and I could appreciate that he really liked working on the farm and acquiring experience working with me, but my daughter was a very good student and she needed good education. She is now at university studying to be an accountant. My wife went to the city to look at houses, and I trusted her decision totally. She found a house, told me the price by phone and I went to the city just to confirm her decision and pay for the house. To buy the house I had to sell almost all the animals I had on the rented land..."

It is obvious from this tale how a family objective becomes a priority in relation to a farm decision. The FD-MU in evolution needed to find a balance in order to satisfy both family objectives and the needs and farm objectives, costs and investments. Somehow, farm activities took precedent in the early years and then it was the children's education. A clear intergenerational link is established: the farmer learning from his father and older brothers, and later teaching his own son his own knowledge and skills. His son started to work with him in 1991 at the age of 20 and now he gave to him 400 hectares and the animals. He considered that the best was for him to learn through his own experience, but obviously supported him. Local knowledge and skills acquired by one generation farming almost the same farms where they grew up are transferred to the next generation. The farmer was also asked about the key factors in order to explain the growth of the farm and he answered:

"When you need to grow, the most important thing is to increase the number of cows. Cows and heifers are the factory of calves - then you need to know that when you are growing you sell only the males and keep the females... But this is not enough, you also need facilities and technology... I like to see farmers' experiences... Before I started to work alone I used to travel in order to see experiences of other farmers here and in Brazil, in Paraguay and in Argentina"

As can be observed, the main objective was farm growth and the strategy considered is very similar to that adopted by the farmer in Case 1. This means that there are similar rules coming from rural people's knowledge but, in this case, he also emphasises the use of new technology. This farmer adopted cross-breeding, pasture improvements, and increased the number of paddocks, etc. The field of information is completely different firstly because this farmer started off with a different economic situation and education and secondly because of his own awareness. The fact that he is looking for technological information and experiences in other places means that he is not satisfied with what he is doing now. Also, he started to use the public extension services in 1968 and continues up to the present time. An important consideration is the evolution of his relationship with the agronomic adviser, the clerk and the accountant. The relation started with some initial problems the farmer had. In this first stage, the farmer used them as "sounding boards" mainly validating information he already had but also validating their answers. In a way, he also tested how good they were as "sounding boards". Once successfully validated several times over, a closer relationship was established and they began to be considered more as "information digestors". That can be appreciated in the following answer:

" I have a close relation with my advisers, in a way they are more my friends than my advisers and I know they also consider me as a friend. You need to have friends to trust with your problems. You do not go trusting your problems to strangers. It is not only that you need to know the subject but he must be a nice person... "

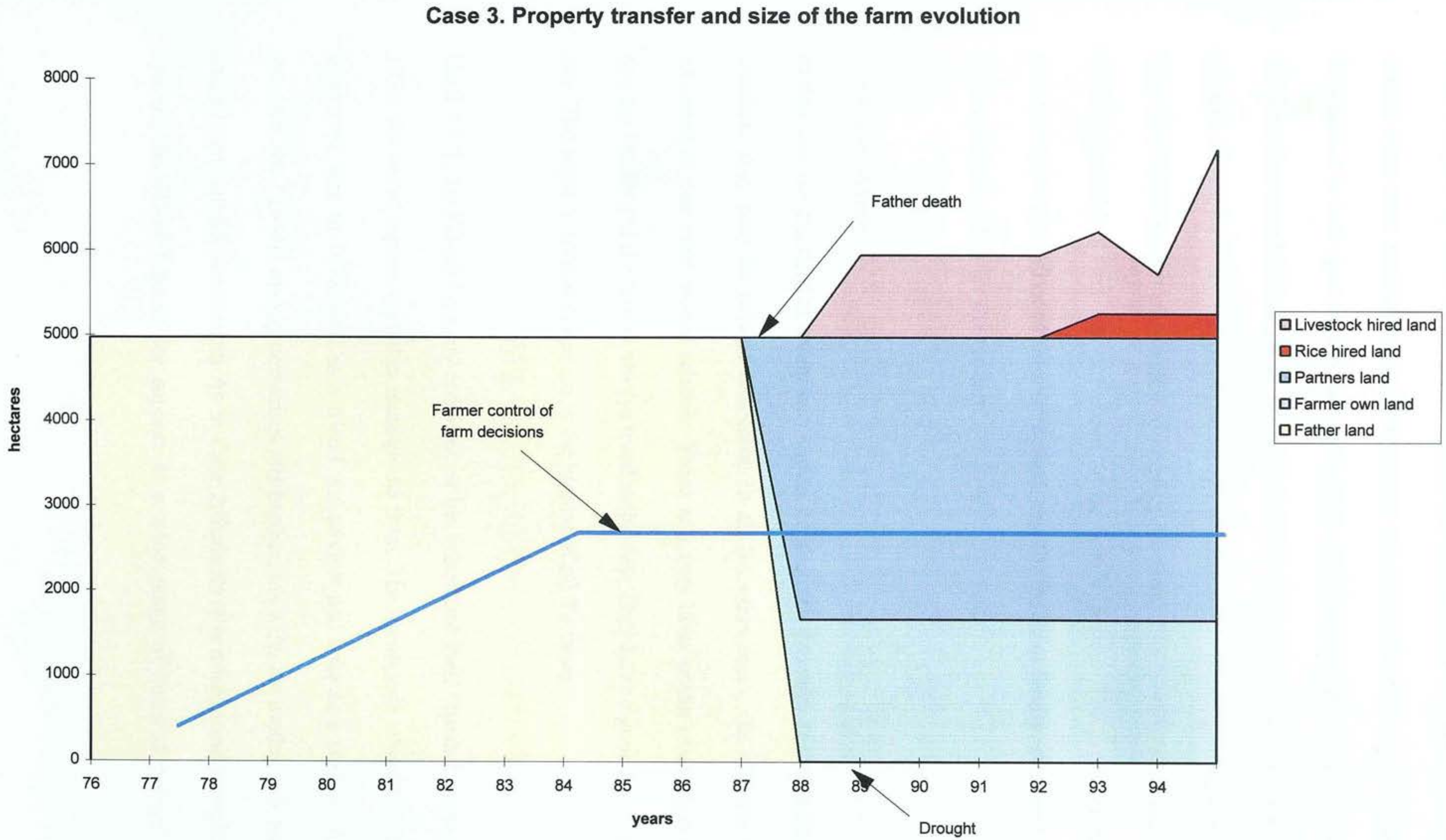
Therefore, the FD-MU evolution in this case is more complex than in Case 1, and "trusted people" are beyond the family: the adviser, the clerk and the accountant have an important role as technological, economic and financial "information digestors".

Case 3

Farm size evolution

Case 3 belongs to the group of "entrepreneurial imitators". In this case also, the farmer belongs to a family of farmers, but they also had an inherited off-farm activity related to a stock and station agency for wool and leather. There are two sons and he is the eldest. The property transfer and evolution of the size of the farm is presented in Figure 8.4. His father inherited 1500 hectares and he increased the size of the farm to 4932 has. According to the farmer, his father was an innovative person and he liked adopting new technology and developing experiments on the

Figure 8.4. Case 3. Property transfer and size of the farm evolution



farm. He grew up working and learning with his father, but he was also developing a mental plan about how to change and improve the system his father was managing. The farmer is now aged 44 and has a veterinary qualification. He started working in 1977 and increased his weight in the control of the farm until 1984 when his father became ill and he took control of the farm's decisions. His father died in 1987, and they decided to make a partnership to manage the farm. The income obtained in the off-farm activity is very low compared to the farm's income. The profit of the off and on farm work is divided into three parts: one for the farm family, another for the brother and the other for the mother.

FD-MU evolution

In this case the standard of living was higher, as were the expenses for educating the children: they paid for private education. In all the other cases, the children were educated at free state owned schools. There is a very clear urban orientation here, and the family and the farmer always lived in the city. They have a good house in the city. The input of formal education is the highest of all the cases.

Until 1977, the FD-MU mainly consisted of his father and their "trusted people". In 1978, the actual farmer started to manage the farm. The agronomic adviser started to work with him in 1978: first as a friend and adviser and now as a partner. At the moment, the FD-MU mainly comprises his brother, his wife, his mother, his partner and adviser and his accountant. As in Case 2, because it is a large and complicated system, the FD-MU looks for support in a wide range of "trusted people" and "sounding boards". The FD-MU is more complex and apparently requires of special activity to manage information for each subsystem (cattle, sheep, pasture, rice, dairy). In this case, rural people's knowledge is not so relevant as in the other two farms, and the use of formal channels of communications related to each subsystem appears clearer. The adviser and partner "digests" technical information, the wife and the accountant "digest" the financial and economic information, while the brother and the mother act as "sounding boards" in order to validate or reject information for decision making. It appears that the FD-MU is more entrepreneurial and requires more "trusted people" and "sounding boards".

During 1989, the effects of the drought produced major damage to their production system and the price of wool dropped in 1990, therefore the profitability of the farm decreased. They were forced to diversify income streams, hiring more land at first, then starting a dairy farm and finally producing cash crops. When the farmer was asked about what was the main objective he responded as follows:

"The main objective was to produce more but always looking at the profitability. My father never applied for a loan. The strategy was to reinvest the income surplus in the farm after covering for all the family expenses. In this way, he improved the farm facilities. For instance, the farm now has 33 paddocks."

Analysing this answer, it is clear that this farmer is more entrepreneurial and is looking for profitability and income increase. In this case, the strategy for growing is not based on the animals but rather on capital management and profitability. The family is more market and urban orientated. The fact that the other activity is a stock and station agency indicates that there is a more entrepreneurial vocation and the most important sources of information are related to the markets. This became clear when the farmer was asked about the main objective of the off-farm activity.

" The stock and station agency of wool and leather was profitable when my grand father worked on it. But now the profitability is low and there are mainly two reasons to preserve this business: first because it is a very good source of information about markets and second for tradition and in order to have an office to centralise all the records and information on the farm. My wife works in this office keeping records in the computer and organising my work, and we also have some employees."

It is apparent that information is considered a very important resource and they maintain an activity for which the main objective is to concentrate and process mainly economic and financial information. This is the only case where the wife participates actively, helping in the farm's management. She is not only managing and processing farm information in the computer, she also co-ordinates and manages the farmer's agenda. In a way, she is acting as an "information digestor" processing and analysing information from different sources but is also acting as a "buffer" filtering out small problems. The increase in complexity requires that more information functions need to be carried out for the FD-MU.

Resume of FD-MU and farm evolution features

A summary of the main characteristics of FD-MU cases, features and "trusted people" at the end of the period analysed are presented in Table 8.1.

As can be seen, the process of evolution and adaptation of the FD-MU had developed three different patterns of behaviour that are also the results of different inner mechanisms for supporting decisions.

A visual comparison between the case studies' results (Table 8.1) and the average results obtained for the FD-MUs (Table 7.3) was performed in order to validate the representativity of the case studies selected.

As may be seen from the Tables' comparison, there are major similarities among the results obtained for the cases and the results obtained from the typology. Therefore, the results suggest that the cases selected for the set of variables analysed are broadly representative in terms of decision support, information, analysis, knowledge, farm organisation and main production objectives.

Table 8.1. Main characteristics of FD-MU cases, features and "trusted people" at the end of the period analysed.

Feature	Case 1, selected from "Traditional routine" FD-MU type	Case 2, selected from "Innovative sustainable" FD-MU type	Case 3, selected from "Entrepreneurial imitators" FD-MU type
Decision support system	- Simple	- Medium complex	- Complex
Information digestors	- Decision maker	- Decision maker - Son - Adviser of public extension services. - Accountant - Clerks	- Decision maker - Private adviser and partner. - Accountant - Wife - Foremen
Sounding boards	- Foreman, son, other farmers, wife, relatives and friends	- Brothers, son, wife, foreman, other farmers relatives and friends	- Brother, mother, relatives and friends
Information sources	Local. Mainly informal Own observation, family, friends, foreman, local auction markets, mass media	Local and regional - Informal and formal Own observation, advisers, family, friends, local and national auction markets, stock and station agencies, mass media, public extension services, research.	Local and regional - Formal and informal mainly digested information from, private advisers, family, foremen, friends, local and national auction markets, stock and station agencies, mass media, public extension services, research.
Use of analysis or intuition	Intuition	Intuition and analysis	Intuition and analysis
Main knowledge used to support decisions	Rural people knowledge	Rural people knowledge and formal knowledge	Formal knowledge and rural people knowledge
Strategic decisions	Decision maker	Decision maker and family	Decision maker, family and advisers
Tactical decisions	Decision maker	Decision maker, family, and advisers	Decision maker family and advisers
Operational decisions	Decision maker, son, wife of the son and foreman	Decision maker, son, foreman, labour	Adviser, partner, foremen, labour
Organisation	Family	Family	Entrepreneurial
Main production objective	Increase production by increase the size of the farm and herd on the basis of minimise the use of external outputs.	Increase production by: Increase the size of the farm and productivity by adopting and adapting newest technology and by developing own experiments.	Increase production and profitability by: - Increasing productivity. Copy of the proved technological package developed by INIA and the University and widely used in the south west of the country, diversifying farm activities

8.4.2. Management during the drought.

Case 1

The predominant strategy followed by this case during the drought was to sell off animals. The behaviour was mainly passive, waiting for the situation to change.

"There is not much to do when we have a drought; the only thing to do is to wait until it rains again"

The behaviour is mainly oriented to developing a strategy to cope with external changes without introducing modifications to the traditional production system he is managing. The FD-MU mainly tries to cope with the drought, avoiding investments or increasing the level of inputs on the farm. The behaviour was mainly a passive one, in the sense that he lost animals, he saw the problems, and the only decision he made associated with the drought was to sell some animals and after that, just wait for external changes to take place. The farmer recalled some information he had from another big drought in 1942 and he compared the new information to the old, but not for making decisions, but rather just to compare how strongly one related to the other. He did not change his routines and the explanation was simply that there was not much that could be done against the drought. His decisions are focused on how to adapt his management to economic and natural cycles. Therefore, in order to know more about the working environment, he is mainly looking for information on the radio mass media, about weather forecast trends and market prices' changes. The control and monitoring of the animals and pasture is low and mainly based on traditional methods. For instance, he uses kerosene to control eye diseases instead of the medicinal product recommended by the veterinary.

"*During the drought I needed to sell my animals and I received a very bad price, less than a third of the real price, but I did not have an alternative. If I had not sold these animals, a lot would have died in the farm. Then to sell the animals was a good decision*".

The traditional farmer usually does not look for alternatives that come from other sources than rural people's knowledge. They consider that there is not much to do within the farm, and farm profitability is associated to economic and biological cycles. They perceive that new technology promotes an increase in production costs and a dependence of the system on new external products and therefore, increases the risk. They consider that an increase in the inputs and in the family living standards introduces instability to the system. His decision support is reduced to a very small number of "trusted people", and he mainly bases decisions on the reaction of "sounding boards". The main "information digestor" is himself. Related to the household, the decision was to reduce the expenses and consume mainly farm products: in other words, minimised the standard of living. It is clear here that production objectives were prioritised against family household objectives.

Case 2

In this case the farmer responded actively, increasing the field of information search. He increased the number of "trusted people" to be consulted in order to find solutions for the farm. Direct reading of scientific publications or research results is not often used by the farmer as a source of information. The radio is the most common mass media the farmer uses to gain general information and also price trends. The strategy developed was to buy some food supplements and increase the monitoring and control of animals and pasture. Pasture improvements were managed strategically and the access to the water sources cleaned in order to provide an easy path for the animals. He also went to some seminars prepared by the public extension services and to the research institutions in order to obtain information on measures to alleviate the effects of the drought. Nevertheless, he said that the information of the research institute was not easy to use and therefore he preferred to ask his adviser. The adviser was working close to him in order to help in the management of the improvements, and the adviser used to go to the research institution but was also encouraged by the farmer to search for new information. In this case, the adviser is acting as a typical "information digestor". The adviser went to the research institutions, and different strategies to cope with the drought were presented. Therefore, he is receiving information from different sources, processing and analysing it and acting as an expert, encapsulating knowledge in simple rules, to provide advice to the farmer. The family was encouraged to reduce consumption levels. In this situation of crisis, the FD-MU searched for alternatives and information to avoid big losses. The clerks and the accountant were also asked their opinion.

Case 3

As a result of the drought, the FD-MU responded actively, enhancing the information search but, because they have a higher standard of living compared to the other cases, they searched for a more strategic change. The new information search routine was on how to increase the profitability of the whole system. In the short term, in order to reduce losses, they sold animals and looked for land to agist in the south of the country. In the medium term, they were looking for a more strategic change in analysing information about the possibilities to diversify the system including dairy and cash crops.

"During the drought we looked for land to adjist in the south of the country and we sent animals 300 kilometres away from the farm. Despite all we did, we estimate our losses at US$ 400,000. Until the drought, the Extensive Livestock Production System [ELPS] was okay, and we have quite a good control of the farm and the income obtained was enough to maintain our living standards. The drought damage and the low profitability of ELPS because of the fall in the price of wool and beef cattle in 1989, forced us to change. After the drought, we diversified activities: dairy first, and rice and wheat later on".

This FD-MU shows a more entrepreneurial behaviour pattern, and responded with major strategic changes in production systems. The FD-MU's behaviour in this case follows the line developed in Chapter 5, that farmers do not make strategic changes until a strong internal or external event forces them to change. There are also two important considerations: first, that these changes forced the FD-MU to redefine objectives and establish a new strategy of action in order to search for solutions for the farm and the family in the medium and long term and, secondly, they were looking for information out of the traditional offer of technology for ELPS. They diversified the farm, including two completely new activities, dairy and rice. This implies that they had moved completely out of the normal search routine for information. The idea to start rice production came from his brother, who does not work in the farm. He and the adviser analysed the proposal and decided to adopt the new activity. These changes not only affected the farm's production system, but also produced changes in the household pattern of consumption.

"When you diversify, you do not have the capacity to look after all the activities, then you need to delegate decisions and activities on more people and you effectively loose control in some cases. When I was only working with the ELPS I was controlling the decisions, directly at the farm. But now I am more concentrated on the rice management. The reason is that the difference between good and bad management in the ELPS can be of US$ 10.000 a year, but in cropping rice this difference could be of US$ 100.000. Therefore, I concentrated my efforts on the rice and dairy production and the ELPS is mainly managed by the foreman. This was my

grandfather's foreman. He has been working with us for 50 years. I know I need to put another person to manage the farm because he is too old, but I keep him on for humanitarian reasons, and also to avoid problems with relatives. In the dairy farm and the rice farm I also have foremen.

Analysing this comment it is possible to suggest that diversification increases the complexity of the FD-MU and therefore the people involved in the production system, such as the foremen of the ELPS, the dairy and the rice farms. It appears that some of them act as "trusted people" at an operational level. Also, information suggests that when the complexity increases, the need for effective decision support increases. At first, the information support subsystems were mainly related to home economics, animal and pasture management decisions, economic and financial decisions, investments and day to day decisions related to the ELPS. Because he diversified the farming activities, he needed to make decisions at higher levels of hierarchy and therefore required more "digested information" about what was happening in the different subsystems. This meant that he needed to delegate more tasks and more information on "information digestors" that worked close to the production system. Now he needs "information digestors" and "sounding boards" in cash crops and dairy production. Finally, when he inherited the farm, he also inherited "trusted people" of the past generation such as the foreman and other people involved in the production system. Despite the entrepreneurial behaviour, conflicts within the FD-MU were avoided rather than being totally committed to efficiency.

Resume of FD-MU response to drought effects

Table 8.2 presents the main differences in the FD-MU responses to the drought effects. The three cases present clear differences in response to the changes.

Table 8.2. Main differences in FD-MU cases' responses to drought effects.

Feature	**Case 1, selected from "Traditional routine" FD-MU type**	**Case 2, selected from "Innovative sustainable" FD-MU type**	**Case 3, selected from "Entrepreneurial imitators" FD-MU type**
Information digestosr	Decision maker	Brothers, public extension services adviser	Private advisor and partner, accountant.
Sounding boards	Son, other farmers	Son, other farmers and friends, technicians	Brother, mother, wife, friends, other farmers and technicians.
Diversification	No	No	Yes
Use of new technology	No	Yes	Yes
Information search field.	Do not change	Enhanced	Enhanced
Monitoring and controlling farm tasks	Low	High	Medium
Attitude	Passive	Active	Active
Use of public extension services	No	Yes	No
Use of private agronomic advice	No	No	Yes
Research institution visits	No	Yes	Yes

8.4.3. Strategy to cope with seasonal production bottlenecks

Case 1

The strategy followed in order to cope with production bottlenecks is simply to reduce the number of animals in winter. Again the knowledge and information used comes mainly from rural people knowledge. The farmer has adopted some technology in order to improve pastures but the results were not so good.

"I improved four hectares of pasture in my farm in 1971. I thought that could be an important investment but, in my case, I lost every thing. The fence was not in good condition and also I did not have any knowledge about how to manage pasture improvements. I also improved 13 hectares, but I lost everything during the drought. As you can see, buying land is more secure..."

He improved a few hectares based mainly on the access he had to a very soft loan provided by the extension services. However, his main objective was to develop the improvements in order to gain position for a greater loan in order to buy more land. The strategy of the FD-MU is to sell some animals in order to reduce the stocking rate. They do not apply any special care for the animals. For instance, he does not apply vermicide or other drugs to control animal health before winter. All the system is based on the use of rural knowledge, intuition and informal information in order to minimise inputs in the production system and consumption in the family household. As in the other sections analysed, the support of "information digestors" in this case is very low because the main "information digestor" is the decision maker.

Case 2

This farmer gradually introduced changes in the production system in order to cope with seasonal bottle necks. He looked for information from other farmers and also in the public extension services. He went to technical meetings in the experimental fields and therefore he knew what the agricultural research institute was doing, but he said he preferred to carry-out his own experiments with the support of the extension services. He likes to innovate and introduce the latest technology. In fact, he developed some experimental research on his own farm with the support of "trusted people" of the extension services. In order to cope with seasonal stress, he mainly uses information from "information digestors" of the extension services and to a lesser extent, from the rural people knowledge such as the foreman.

The behaviour is then innovative but concentrated on gradualist and small improvements of ELPS, he never considered diversifying the farm to crops; he is mainly concerned with innovating by increasing and diversifying the source of feed for the animals. But the main objective is to increase production levels and efficiency of the ELPS. The strategy here is for gradual improvement focusing on the achievement of intermediate goals that do not lead to major changes.

Case 3

This more entrepreneurial FD-MU is trying to "copy" the more intensive rotational systems successfully used in the North East of the country. It involves the integration of cash crops and improved pastures to increase the productivity of the whole system. He tries to use most of the information available, and the "technical information digestor" would go to research institutions, the university and farmers' organisations in order to collect information to define alternatives to the current production system. Once the "technical information digestor" has analysed the information, a meeting is held with the decision maker in order to discuss and analyse the different alternatives for improvements. According to the farmer it is crucial to have an adviser because he himself does not have the time to collect and analyse much of the technical information. They are moving now, after the drought, to a major strategic change in order to promote the intensification of the whole system based on the integration of rotational cash crops, dairy production and improved pastures.

Resume of FD-MU strategies followed in response to seasonal production bottlenecks

Table 8.3, presents the main strategies to cope with seasonal production bottle necks. They can be divided into strategies to: i) increase the quality and quantity of feeding, ii) decrease the stocking rate iii) increase animal and pasture reserves to be transferred to the seasonal bottle neck iv) improve animal condition and health and v) increase control and monitoring of animal and pastures

It can be seen from Table 8.3 that there are many differences, principally between Case 1 compared with Cases 2 and 3. The "trusted people" involved in decision support acting as "information digestors" and "sounding boards" are different. However, these are the only strategies followed by Case 1 whose strategy is to have very low inputs to the production system. In Case 2 a more integral strategy is followed and the differences with Case 3 are less.

Table 8.3. Main strategies followed by the FD-MU in response to seasonal production bottlenecks.

Main strategy	Case 1, selected from "Traditional routine" FD-MU type	Case 2, selected from "Innovative sustainable" FD-MU type	Case 3, selected from "Entrepreneurial imitators" FD-MU type
Information digestors	Decision maker	Brothers, public extension services adviser	Private adviser, foremen
Sounding boards	Son, foreman, other farmers and friends	Son, foreman, other farmers, technicians and friends.	Technicians, brother, and friends
Sell animals before winter.	Yes	Yes	Yes
Mineral supplements in winter	Yes	Yes	Yes
Increase pasture improvements	No	Yes	Yes
Beef cattle weaning before winter	No	Yes	Yes
Move some animals to sandy soils	No	Yes	No
Special health treatment before winter	No	Yes	Yes
Increase monitor and control in the animals and pasture	No	Yes	No
Transfer pasture from the autumn to winter	No	Yes	No
Use of cross-breeding	No	Yes	No
Use of scale for control animal weight	No	Yes	No

8.4.4. Borrowing money strategies

Case 1

The strategy of this FD-MU is mainly reluctant to borrow money and the information to explain this behaviour can be found in some comments of the farmer.

He borrowed money in 1970 in order to buy land. To obtain a soft credit he improved 4 hectares of pastures.

"This was the most stressful period in my life as a farmer. I did not have enough capital to buy this land, and I applied for a loan. I received 5 or 6 letters from the bank with deadlines for payment. I could not sleep properly during that year. I was close to loosing all I had. If had not received the support of the Bank's manager who trusted me and extended the deadline I would have lost everything. That was the only occasion I applied for a loan"

From this comment it is possible to suggest that the FD-MU in this case borrowed money mainly in order to increase the size of the farm which was his main objective. He made some pasture improvements but mainly to have a justification for applying for the money in order to buy the land. During this period the bank manager was one of his main "trusted people". According to him, the manager helped him to estimate and forecast future incomes in order to define a strategy to pay back the loan.

Case 2

The FD-MU in Case 2 demonstrates the opposite behaviour, having incorporated the application for loans into his routines. This may also be appreciated from the following farmer's comment:

" I borrowed money. I did not think that to save your money in the bank was a good decision. The best you can do with your money is to reinvest as much as you can in your farm. Because I often do not have enough money to invest in buying land or developing facilities, I borrow money. I never take an economic or financial decision without talking with my accountant. He has worked for 18 years in the Bank which I borrow money from. Then he provided not only the best lines of credit but also gave me advice about when to borrow and how to pay back."

From this comment it is possible to appreciate the very different behaviour between this case and Case 1. The FD-MU in this case has a particular "information digestor" that provides advice about how and when to borrow money. The strategy is to reinvest his own capital and also to borrow money in order to improve or expand the business. The credit has been mainly used to improve farm facilities such as increasing the number of paddocks, maintaining fences in good conditions, buying bulls or rams, improving the quality of water for the animals, etc. Therefore, this FD-MU developed a strategy of "gradualist introduction of changes to improve the ELPS". He is not just looking for information about how to improve pastures, but also for more permanent improvements.

Case 3

This case has been reluctant to apply for loans. Despite that, because of the drought effects, he was forced to do this in order to develop the necessary infrastructure to crop rice and, later, wheat. He had a debt of about US$ 450,000.

"For us, who had never applied for a loan, this was a very stressful period. With rice, the volume of money managed is so big that it is very dangerous to make mistakes. With the ELPS we use to spend about US$ 2000 a month, but with rice the amount is about six times more: US$ 12000. You need to always have advice from an accountant. Just as an example, in 1994 I invested US$ 210,000 to crop the rice and I obtained US$ 240,000. This year I invested US$ 240,000 and I hope to obtain US$ 500,000. With this money I can pay all my debts and sleep calmly again. I do not think I will borrow money again"

Analysing this comment it is possible to appreciate that external changes forced the FD-MU to make strategic changes and to bring in more support from "information digestors". Given that borrowing the money was associated to major changes and involves risk, the FD-MU enhanced the capacity for information search. In this case, the adviser was searching for technological information about the possibilities of diversification. At the same time, all the members of the FD-MU were involved in a participatory process to discuss the different probable paths. The brother was an active participator and suggested diversification. Therefore, because borrowing is considered a risky alternative, the FD-MU enhances the information field by increasing the number of "trusted people" to be consulted and get some specialised "information digestor" and "sounding boards" as the bank manager, advisers and farmers of the rice association, etc., involved.

Resume of FD-MU strategies for borrowing money

According to the results presented, the normal behaviour in Cases 1 and 3, is a reluctance to borrowing money. Only under very special circumstances will they take credit. Money was borrowed to introduce changes in their systems according to the needs and perceptions. In Case 1, changes in the production systems are perceived being associated to an increase in the scale of production. The FD-MU borrowed money in order to buy more land. In Case 2, the perception is different and changes are gradually introduced using borrowed money. Here, the objective is not only to increase the scale of production, but also to increase productivity and farm facilities in order to better control animals and pasture. In Case 3, the FD-MU borrowed money in order to introduce major strategic changes in their production system in order to increase profitability and production, enforced by the combined effect of the drought and the drop in wool prices.

The only time Case 1 required the support of an "information digestor" was when he borrowed money. Obviously, the FD-MU did not have any background in financial decisions and looked for support from the bank manager first and a lawyer when he had problems in repaying the loan. "Sounding boards" are mainly the family, friends and other farmers.

Table 8.4. Main strategies followed by the FD-MU in order to borrow money.

Main strategy	Case 1, selected from "Traditional routine" FD-MU type	Case 2, selected from "Innovative sustainable" FD-MU type	Case 3, selected from "Entrepreneurial imitators" FD-MU type
Information digestor	Bank manager, lawyer	Accountant, adviser and clerks	Accountant, private adviser and partner, brother and clerks
Sounding boards	Family, other farmers and friends.	Brothers, wife, son, other farmers and friends.	Wife, mother, friends. bank manager, rice farmers association.
Borrow money only in special circumstances	Yes	No	Yes
Use to borrow money for invest in the farm	No	Yes	No

Case 2 is the only one that has a routine for information search in relation to borrowing money, supported by "information digestors" (accountant, adviser and clerks) and the encouragement and validation of "sounding boards" such as brothers, the wife, the son, other farmers and friends.

Case 3 borrowed money to bring about major strategic change, enhanced the FD-MU, and "information digestors" and "sounding boards" that are not normally involved in the support of decision making.

The main behavioural features of the FD-MU cases, when compared with the FD-MU "types" described in Chapter 7, present similarities. These findings suggest that the cases selected are broadly representative of the FD-MU "types" from which they were taken. This indicates that the procedure followed in order to select the cases, by discriminant analysis, has located cases broadly representative of the FD-MU "types".

8.5. Summary of considerations

This chapter has been devoted to the analysis of the information gathered through a case study methodology. Looking at the results of the case study presented in Chapter 8, it is possible to suggest the following considerations:

Inter-generated FD-MU features.

The FD-MUs analysed behave as family business (Errington and Tranter 1991; Gasson and Errington 1993; Errington and Gasson 1994) where ownership, farm management and control are transferred from one generation to another, involving the same family, "trusted people" and farm. This means that inheritance does not just involve the land and that most of the influential "trusted people" attached to the FD-MU will continue influencing the decision making process. It also means that the production system, labour skills, work style, organisation, decisions routines and rules, management practices, sources of information, knowledge, farm lifestyle, cultural and ethical values and beliefs will also be inherited. The FD-MU is a complex unit, comprising the decision maker and "trusted people" which evolves by controlling the farm and the household. Within this evolutionary process, the FD-MU can be seen as learning and seeking paths in order to cope with uncertainty and imperfect information and transferring a set of validated and proved "trusted people", routines and rules to the next generation. Some of the information search routines supported by "sounding boards" and "information digestors" will also be transferred to the next generation in order to manage the farm on the basis of their beliefs, knowledge, traditions, cultural and ethical values.

Perception of production system by the FD-MU.

The three FD-MUs have different perceptions regarding their families, production systems, problems, as well as the strategies to follow in order to solve those problems. These different perceptions are the result of a different world view that results from their past experience, knowledge, tradition, social status, cultural and ethical values. The results obtained suggest that the differences in production systems are best explained as a result of the evolution of socio-economic and cultural values and objectives of the FD-MU. Apparently, these differences are stronger than the differences among the production systems and could explain why a technological pattern adopted for one type of FD-MU is not adopted by another. Therefore, dividing farmers into recommendations domains can help to better identify real problems of the different groups and to better target research in order to solve them.

FD-MU objectives

FD-MU objectives are not constant over time; they are adjusted to the dynamic requirements of the farm or the household. This means that the FD-MU in many cases will need to prioritise between conflicting farm objectives and family objectives. Information obtained suggests that in the early stages of farming, production and farming decisions will be prioritised and that in the later stages, education of the children and family objectives will take precedence.

FD-MU adaptation process

The three cases have developed different strategies in order to cope with changes that have led them to growth. These different strategies have been the result of different mechanisms of information search and decision support based mainly on "trusted people". In Case 1, the strategy is related to minimal family consumption and costs and to the expansion of the scale of production. In Case 2, the strategy is principally based on reinvestment of income in improving farm facilities and productivity. The major concern is the introduction of gradual changes in the production system, based on the adoption of new technology and improved practices. In Case 3, the strategy was farm diversification. In order to maintain living standards they were forced to introduce sharp modifications in the production systems, looking for an increase in the system's profitability.

Rural people's knowledge.

In all cases rural knowledge plays an important role (Table 8.5). However, there are important differences among the groups.

In Case 1, rural knowledge and informal information are used to support strategic, tactical and operational decisions; in Case 2, a balance between formal and informal knowledge and information is used: strategic decisions are mainly supported with formal information and rural people's knowledge; tactical decisions with a mix of both, and operational decisions mainly with rural knowledge. In Case 3, the weight of formal information and knowledge is higher, and rural knowledge is used mainly to support operational decisions.

Table 8.5. Type of knowledge, information and analysis used for decisions support for the three cases analysed.

Decision	Case 1, selected from "Traditional routine" FD-MU type	Case 2, selected from "Innovative sustainable" FD-MU type	Case 3, selected from "Entrepreneurial imitators" FD-MU type
Strategic	-Rural people knowledge, -Informal information -Intuition	Mainly formal knowledge - Informal & formal information. - Intuition & analysis	Mainly formal knowledge - Formal & informal information. - Analysis & intuition
Tactical	-Rural people knowledge, -Informal information -Intuition	- Rural people knowledge and formal knowledge. -Informal & formal information - Intuition & analysis	Mainly formal knowledge - Formal & informal information. - Analysis & intuition
Operational	-Rural people knowledge, -Informal information -Intuition	-Rural people knowledge, -Informal & formal information -Intuition & analysis	Rural people knowledge and formal knowledge, informal information and intuition

Production systems' monitoring and control.

In order to control and monitor the production system the three cases have developed different easy, clear and understandable rules that are validated against its own observation, beliefs and cultural traditions. In Case 1, these rules come mainly from local rural people knowledge and are applied every year with little changes. In Case 2, the rules are developed mainly by mixing informal information channels as rural people knowledge with more formal channels of information as the agronomic and economic adviser. In Case 3, is where the weight of formal information is higher, but they also use local rural people knowledge in order to implement mainly operative decisions.

Information functions of "trusted people".

Analysis of the cases suggest that "trusted people" have different informative functions. In Case 1, the response to change is by organising a very simple FD-MU where the main "information digestor" is the farmer. Almost all the tasks are performed by his direct control or action. "Trusted people" act in this case mainly as sounding boards. In Case 2, the complexity of the FD-MU increases and there are clearer boundaries among the "trusted people" supporting decisions for different subsystems. Farm record keeping and processing, agronomic advice, economic and financial analysis are mainly carried out by some specialised "trusted people" who act mainly as "information digestors" and provide the decision maker with the results of their analysis.

Despite a clear input of "information digests" as channels of formal information, the use of informal channels of information as rural people knowledge is high. This case has an innovative behaviour and some experimental research has taken place to test and validate some of the practices. Scientific and rural knowledge is then amalgamated in order to support decisions.

Case 3 has the more complex FD-MU organisation and there are more tasks delegated to different "trusted people". Diversification of the production system as a response to changes requires a higher degree of specialisation in the informative tasks performed by the "trusted people". In order to have a "view" of the whole system, the decision maker moves his actions to a higher level of control. The system is split into different subsystems with clearer boundaries and functions where control, monitoring and performing tasks is delegated on more specialised "trusted people".

However, there is an "information digestor" in each subsystem who is the main reference. The FD-MU appears to have different "layers" of trust and the decision maker enquires the main referent first. Some decisions are made just by consulting the referent "information digestors" in the subsystem. These are decisions regarding clear actions. Other cases where the solution and action are not clear, involve a more complicated interaction within the "trusted people" attached to the FD-MU.

"Information digestors" and "sounding boards" are consulted to clarify the problem and to discuss possible solutions. Information also suggests that "Information digestors" and "sounding boards" change according to the perception of the decision maker of the reliability of their answers. That means that if an "information digestor" does not provide good answers, then that person will not be used as an "information digestor".

On the other hand, "sounding boards" who validate their questions in a satisfactory way can be considered later as "information digestors". In fact, this different complexity related to "trusted people" involved in the FD-MU can be assimilated into the Röling (1994) concept of decision making "platforms". He divides the system into different levels of hierarchy and within each level, he differentiates between the physical production system and the decision making "platform" that makes decisions about the system. The "trusted people" and the decision maker could be assimilated into the Röling "platforms" of decision making. These "platforms" are strongly affected by the traditions, beliefs, social, cultural and ethical values that can be partially explained through the FD-MU's evolution.

Following Dent (1994), who hypothesised that the "platform" could be viewed as a nested group of decision support systems, where the platform involved not only has a view of the FD-MUs objectives but also controls the extent to which objectives in each subsystem are fulfilled or not. The results obtained suggest that decision support systems at farm level are organised in this fashion. In Case 1, the FD-MU is comprised of a very simple platform of decision making where the decision support system mainly involves the decision maker and "sounding boards". As the complexity of the system increases, the "platform" is split into different decision support systems such as in Cases 2 and 3.

Information search routines.

Results suggest that the rationale of the FD-MU is not based on objectives related to maximising profit, but is based on heuristic rules and information search routines that involve "trusted people". These specific information search routines and heuristic rules will be used as long as satisfactory results are being achieved. In the analysis of the cases, three patterns of FD-MU behaviour are represented. Case 1, "traditional routine" responds to changes using indefinitely the old routines and heuristics rules, mainly developed by observation and rural people knowledge. Case 2, the "innovative sustainable" responds to changes by investing and adopting technology in order to obtain a gradualist improvement of the farm and Case 3, the "entrepreneurial imitators" responds by taking major strategic changes in the production system. These findings reinforce the evolutionary assumptions made in Chapter 7 that the three groups obtained represent the result of different adaptive learning patterns. In the evolution of the FD-MU, by trial-and-error, satisfactory rules are retained and rules that fail are discarded (see Section 8.4.1).

Evolution mechanisms.

Farmers do not introduce major strategic changes until a major event forces them to do it. The three different FD-MUs behaviours suggest that Case 2 evolved more on a basis of the introduction of gradualist changes and Case 3 followed a "punctuated" mechanism of evolution. According to Reggiani and Nijkamp (1994) the main discussions about the nature of economic evolution is between

1. "gradualist" as Marshall (cited by Reggiani and Nijkamp 1994) who argues that economy and human society evolve gradually,

2. Schumpeter (cited by Reggiani and Nijkamp 1994) who argues that changes are explained by "punctuated" evolution - that there is no change until a major event takes place, and that periods of change are followed by periods of stagnation - and,

3. Boulding (cited by Reggiani and Nijkamp 1994) who argue that development is characterised by a mix of "gradualist" and "punctuated" changes. The results obtained appear to reinforce Boulding's arguments, in the sense that Case 1, "traditional routine", can represent the maintenance of old routines where no evolution takes place; Case 2, the "innovative sustainable ", who seeks for change and innovation trying to achieve goals gradually but looking at the whole system; and Case 3, the "entrepreneurial imitators", who introduce major strategic changes in selected parts of the production system in response to major external changes.

Chapter 9

Conclusions and Implications

9.1. Introduction

This thesis has analysed the consequences of the application of a simplistic model of farm decision making to support agricultural policy, research and extension and claims the need for a more holistic model which can provide a clearer understanding of the inner mechanisms of the decision making process at farm level. Models for extension used over more than 25 years have been established on the following simplified bases:

- Free market is the most efficient way to allocate resources.
- All farms will respond to measures oriented to maximise economic income.
- Continuous evolutionary and dynamic processes, have been reduced to static concepts (Millar 1993).
- Research and extension resources have been allocated to provide solutions to an average commercial farmer (Chambers 1989).
- Technology is assumed as scale neutral and therefore, will be equally adoptable by all farmers (Hildebrand 1986).
- The main objective of research and extension is to increase productivity.
- Transfer of Technology schemes considers farmers as passive receivers of "outside" expertise without having influence on technology development

(Röling 1994) (the value of rural peoples' knowledge and farmers diversity has been ignored).

• Knowledge generation is biased to high input and commercial agriculture (Uquillas 1994).

Low rates of adoption of new technological alternatives offered in areas of extensive livestock production systems such as the basaltic region in Uruguay indicates that this old concept is not providing good results. The thesis rests on two interrelated assumptions:

1. This lack of adoption of technology is principally explained by a lack of understanding of the basic characteristics of the decision processes of farm families, a poor and inadequate user involvement in technology development and an improper or incomplete appreciation of the driving forces of technology adoption (Dent 1993; Alessi *et al.* 1994).

2. Rural people's knowledge is a valuable resource that has been ignored by the scientific community.

Based on these conditions, the main objectives developed for this study were:

1. To understand better the decision-making process of extensive livestock farmers.

2. To develop decision concepts for research and extension agencies and policy makers.

3. To demonstrate that rural people's knowledge plays an important role in development.

Several implications underlying the study were identified. These implications are presented in the following sections.

9.2. Main Implications

9.2.1 Implications for policy makers

Chapters 1 and 2 have pointed to the fact that globalisation effects put new challenges to policy makers at all levels. The search for economic efficiency and growth has reduced the role of the central state and increased the capacity of the private sectors of the economy. This work also examined some of the impacts of the applied agricultural policies based on a free market and directed towards an "average farmer". These policies have been promoting changes in the socio-economic conditions of the agricultural sector in Uruguay (Chapter 2, Section 2.3.5). Between 1970 and 1980, the reduction in the number of farms was 11 percent, and between 1980 and 1990, 20 percent (Uruguay MGAP-DIEA 1994). These changes impact on rural employment: between 1970 and 1980 there was a reduction of 12 percent and between 1980 and 1990 a further reduction of 11 percent in the total labour employed in agriculture (Uruguay MGAP-DIEA 1994).

On the other hand, a relative increase in the number of farms of more than 200 hectares over the same period suggests capital concentration in large farms. Such farms increased the salaried labour by 16 percent between 1970 and 1980 and had a small reduction of 3 percent between 1980 and 1990. Rural populations geographically, socially and politically are more isolated and less organised than the rest of society and are rarely consulted in the formulation of agricultural and rural development policies (Chapters 1 and 2).

The basic assumption of policy development based on the **laissez-faire** argument for the allocation of resources, is on the foundation of increases in the marginal value of money completely ignoring the marginal social value. These policies have promoted an increasing competitiveness that is eroding rural communities at a high rate. What needs to be clear is that technical change brings about different implications according to the type of FD-MU involved. Policy making has a decisive role in the nature and direction of technical change (Bromley 1991). As presented in this thesis, technical change has important socio-economic implications that are often ignored at policy and research management levels.

The necessary increase of farmers participation.

The thesis has pointed out the need to develop a method that will enable a real participation of the different types of FD-MUs (platforms for decision making) in the elaboration of policies, technical proposals and development propositions (Lardon and Albaladejo 1990; Röling 1993, 1994). As presented in Chapters 2 and 4, FD-MUs are "officially" mainly considered as information and knowledge "receivers". Farmer participation in problem identification, as well as in the alternative solution formulations at policy level, appears to be a way to better channel policy actions. A real increase in FD-MUs participation implies an active involvement of rural communities in the development process. This FD-MU involvement needs to ensure the mobilisation of rural people's knowledge and information in order to promote a sustainable process of development (Brossier and Chia 1986). An approach that includes active farmers' participation appears essential in order to manage problems as complex as the development of agricultural policies for the basaltic area.

Identifying and solving problems related to information and knowledge "recommendation domains".

As a result of the thesis, the analysis of the Equipos survey, and the following classification process, it was possible to identify three main Types of FD-MUs that may be used as "recommendation domains". Also, it was determined that these "recommendation domains", rather than being considered as receivers of services, need to be considered as direct contributors for policy making actions (Chapter 4). FD-MUs grouped into appropriate "recommendation domains" have similar problems, needs, knowledge, information search routines, cultural and ethical values: in other words, they have a similar "view of the world". For example, results suggest that government actions related to credit support and public extension services based on a transfer of technology approach would be accepted by only 14 percent of the existing FD-MUs of the basaltic area ("sustainable innovative" FD-MUs) (Chapter 7, Section 7.5). This means that 86 percent of the FD-MUs regarded debt as a threat to the survival of the farm. These farms have a defensive strategy of minimising borrowing that may well reduce economic efficiency. Case studies show that many FD-MUs do not emphasise economic efficiency and income maximisation in their decision making, rather they prioritise farming and production decisions in the early farming stages and education for children and family objectives in the later stages (Chapter 8, Section 8.4). This suggests that policy needs to be tailored according to FD-MUs' needs. But it is impossible to provide policies for individuals. It is necessary to group FD-MUs into "recommendation domains" with roughly similar behaviour and DSS, for whom a given pattern of communication and recommendation will be broadly appropriate (Williams 1994).

Results suggest that the strategy to identify problems and knowledge needs to be different for each of the groups found in the classification. In Group 1, where farmers base their decisions mainly in RPK, it seems that participatory methods involving farmers in the design of problem solving strategies could be more effective at tailoring the policies to the real needs of these farmers. In the case of Group 2, who have a proactive behaviour, the strategies already used are providing solutions that have been adopted by them mainly because their demands coincide with the main offers of the TOT technology and extension in use. However, these farmers will require special credit policies concerning their need of external capital to cover for investment requirements. To increase the sustainability of the production systems of this type of farmers, special attention to credit policy will be required.

In the case of Group 3, whose behaviour is mainly imitative, pay for advise and are reluctant to take credit, the strategy would need to target on the advisers that act as "information digestors" for them.

As presented, the strategies to follow with each group need to be less supportive in the offer of technical packages to average farmers, and based more on the adjustment of the offer to the needs of the different farmer groups.

The need of policy definitions

As presented in this thesis, FD-MUs populations are clearly complex, dynamic, and diverse. According to the results presented in Chapters 7 and 8, FD-MUs behave as family businesses (Gasson and Errington 1993) where objectives are not constant over time; adjustments are essential to attend the dynamic requirements of the farm or the household (Chapter 8, Section 8.5). Most of the FD-MUs have been farming and managing their resources for long periods of time (Chapter 8). The interaction among elements of the working environment (agroecological and socio-economic) and the household force FD-MUs to develop different behaviours, natural DSS and strategies in order to solve their problems according to the resource availability (Chapters 4 and 8). Dissimilar FD-MUs, have diverse objectives, demographic features, status, education level, skills, cultural and ethical values and, therefore, the information and knowledge actually used to support decisions are also different. This evolutionary process generates many Types of adaptive responses by the FD-MUs (Gasson and Errington 1993; Gafsi and Brossier 1996) (Chapters 7 and 8). In the thesis, three different Types of FD-MUs behaviour were found: "traditional routine", "sustainable innovative" and "entrepreneurial imitators". The questions that need to be solved for policy makers are: i) what kind of dynamic balance among these different Types of FD-MU provides the major benefits for the country and FD-MUs populations with the smallest undesirable socio-economic and environmental effects ii) what are the most desirable models or patterns of evolution for each group of FD-MUs bearing in mind their dynamic interrelationships and iii) how to carry-out the monitoring and evaluation of the evolution of these different FD-MUs populations. Through the more informed participation of all involved or affected by technical change, collective and sustainable policies may be developed.

9.2.2. Implications for information generators including INIA

In Chapters 2, 3, 4 and 5 of the thesis it was concluded that the traditional agricultural research approach has been mainly oriented to the production of new technologies and products rather than to the search of sustainable processes.

Evolving, continuous and dynamic processes are reduced and regarded as static (Millar 1993). Some of the features of this approach highlighted in the thesis are:

- Farmers and farm production systems are characterised through an average farmer and farm production systems consider them isolated from the very evolutionary processes which brought them to the present circumstances:
- Most of the research is considered as scale neutral. That is, it can be equally adopted for small or large farmers (Hildebrand 1986).
- The main mechanisms used for allocating and prioritising research resources have been based on the premise of economic margin (Ferreira, Dabezies and Norton 1990) without explicitly considering socio-economic and environmental impacts of the technologies generated.
- Research decisions are taken without considering the dynamic interrelationships within different groups of FD-MUs.

It appears to be crucial for agricultural researchers to understand that traditional research methods have ignored rural people's knowledge and have an unintentional knowledge bias to those FD-MUs which are economically and financially able to adopt the new high input technologies offered to them. This is not suprising as a natural survival strategy for research workers who need to see their findings adopted.

Determination of public-sector agricultural research priorities

As was presented, the determination of public-sector agricultural research priorities was biased to solve the problems of FD-MUs such as those mainly found in Group 2. Given the results obtained it can be suggested that the strategy for research priorities development needs to be adjusted according to the main type of behaviour of the "recommendation domain". That would demand for internal changes in the research and extension institutions. Stronger internal linkages among farmers, extensionists and researchers would be required. Special feed-back units would be required in order gather information and knowledge and to monitor and adjust the technology offer to the evolving and changing requirements of the three different farmer populations. The main objective of these units is to develop methodologies that can reduce the lack of understanding among farmers, research and extension, by encouraging the participation, gathering and processing information, and by developing mechanisms to increase the links among all those involved in the agricultural development process.

Farmers of Group 1, have by far been the most relegated in the process of research priority settings. It can be suggested that the involvement of farmers of Group 1 is crucial to conduct joint demonstration trials with some pilot farms with predominance of shallow soils to encourage closer integration with this type of farmers. The action research methods that can help in the identification of the chain of "trusted people" that provide support to the different sub-systems of the FD-MU need to be explored. INIA must develop formal institutional methods to effectively integrate this type of farmers who have a right to be involved in setting priorities on the research projects. In the case of Groups 2 and ,3 that are more commercially oriented, new agricultural technology can be transferred with a minimum increase in the research transfer links. However, the involvement of this type of farmers, who are more commercially oriented, can also help to better prioritise research funds by ranking and providing their perception about what their most crucial technological needs are. Nevertheless, once the needs of the different types of farmers are identified, the development of a formal institutional method for priority settings would be necessary in order to help in the "negotiation" for funds allocation among the different research projects (Ferreira, Dabezies and Norton 1990).

Towards the integration of rural people's knowledge into research activities

The thesis has analysed the need of a new paradigm that involves the inclusion of new learning approaches, participatory methods and rural people's knowledge acquisition in order to search for alternatives for sustainable growth (Pretty and Chambers 1994; Millar 1994; Röling 1994; Dent 1994) (Chapter 4). However, the new paradigm should not be seen as totally opposed to the old, as both have strengths and weakness that need to be complemented. The most important point is to recognise that innovation and knowledge is generated by multiple sources where FD-MUs are an important source of rural people's knowledge. This implies a new conception of FD-MUs as knowledge generators and not just consumers of technology (Röling 1990). The importance of rural people's knowledge for sustainable development has been formally recognised by the United Nations

Commission on Sustainable Development UNCED, which included in the Agenda 21, (1993) recommendations to collect and compile information on rural people's knowledge for sustainable development (Chapter 4).

The thesis has pointed-out that the challenge for research is to develop the appropriate interfaces in order to integrate rural people's knowledge and "active" and "natural" rural decision support systems with modern urban scientific knowledge and decisions support systems to form the Agricultural Knowledge and Information System. In it, it would be possible to develop improved DSS and technology within a local context.

According to the literature review, there are no antecedents in Uruguay about how to integrate rural people's knowledge to research activities. This thesis is a first attempt to elicit FD-MUs rules, information and knowledge sources. Despite the fact that it was possible to acquire some basic knowledge with the methodology developed, further research is required in order to create knowledge bases for the different subsystems (pasture, animal, soils, household, etc.) and to confirm these early findings. The analysis presented in the thesis seems to provide enough evidence for the necessity of research programmes to:

- Integrate rural people's knowledge related to extensive livestock production systems into the research programs of pasture, animal and resources management.

• Identify, analyse and select useful informal rural people's knowledge, rules and information sources.

• Analyse all the formal information available at farm level.

• Clarify the nature of FD-MU decision suport systems.

However, one of the main problems to be solved is how to develop efficient methods to gather RPK.

Gathering Rural people's knowledge

The analysis of the thesis results shows that the RPK used by the three groups of FD-MU is different and also that it is communicated in different ways. Most of the literature presented (Chapters, 3, 4, and 5) agrees that the process to integrate RPK to scientific knowledge needs to begin with a process of dialogue and participation but, because the three groups of farmers have shown different behaviour towards change, it would be necessary to develop a different strategy to acquire the relevant knowledge of each group. In the case of Group 1, it can be suggested that the method for developing and gathering RPK needs active and participative involvement apart from the experimental demonstration of the FD-MU's success, for the "trusted people" act mainly as "sounding boards". This is so because the source of RPK used to support decisions comes mainly from the farmer and the family "trusted people". In the case of Groups 2 and 3, the "natural" DSSs are more complex and usually involve more than one "information digestor". The sources of RPK in these cases are broader and, therefore, it is necessary to establish the chain of "trusted people" that provides support in each of the different subsystems (pasture and animal management, economic and financial, etc.).

A suggested methodology for RPK acquisition could be based on this research. Once the "recommendation domains" or groups of farmers are identified, it is necessary to determine which farmers are successfully managing socio-economic and environmental sustainable farming systems. These successful key farmers within each group will have a set of rules and RPK that has lead them to success. These key farmers can serve as pilots to identify knowledge, information and experiences that may be validated and later transferred to the rest of the group. The knowledge and rules of these farmers can then be acquired through the formal introduction of participatory methods and in-depth case studies by applying some standard methods of knowledge acquisition.

An alternative conceptual model for decision support

Based on the literature review, survey and case study analyses, an alternative conceptual model of decision making was developed. This model suggests that the unit for resource allocation at farm level is the FD-MU (Chapter 7, Section 7.8). These FD-MUs are diverse and make decisions mainly based on farmer, "trusted family people" and "trusted people" information, knowledge and world view. According to the analyses of the results presented in Chapters 7 and 8, despite significant differences found in the use of formal information, decisions at farm level are mainly supported by word-of-mouth or oral advice from "trusted family people" and "trusted people" (mainly rural people's knowledge and informal information). The thesis' results suggest that these people have two main different functions within the "natural" decision support systems: one is acting as experts, "information digestors" and the other as information validators, "sounding boards". The case studies (Chapter 8) show that most of the production management rules used to evaluate and monitor the system are a product of rural people's knowledge. The problem is how to integrate relevant informal information and rural people's knowledge into formal decision support systems.

There exists a wide variety of computer models and DSS (Chapter 5) directed to a single farm production process that can be applied to definite environmental factors of livestock production systems (Dent, McGregor and Edwards-Jones 1994). These models are based on known biological functions and individual performances obtained through experimental research (Béranger and Vissac 1994). Despite the contribution of these models to specific areas of knowledge, they are far from the nature of active DSS used by farmers. Most of these models are market oriented and directed to the FD-MUs with entrepreneurial behaviour, i.e. high-input farms. These commercial computer DSS do not incorporate rural and local people's knowledge. The conceptual model developed in this thesis, clearly shows the relevance of informal and local knowledge in decision-making at farm level. It appears that an approach based on both "soft" and "hard" models, directed to different recommendations domains, would be a useful guide for research direction and extension using "natural" communication channels. Methodologies for integrating this knowledge into formal systems (such as expert systems, hybrid models) need to be developed to provide quantitative and qualitative information to support decision making (Dent 1994; Edwards-Jones and McGregor 1994).

9.2.3. Implication for data transmitters

Adapting the offer to the needs

As presented in Chapters 6, 7 and 8 there are different levels of interest among the FD-MUs to technical change (Addendum Appendix 7; Table 7.64). The general analysis indicates that 67 percent of the FD-MUs are not interested in latest technology. The "sustainable innovative" group[1] is more interested in technological changes, and is also the group located in the zone of best natural resources (Agroecozone II, other basaltic soils). The group least interested in technology is the "traditional routine" group[2] that owns the poorest resources (Agroecozone I, shallow soils) (Addendum Appendix 7; Table 7.41). The traditional analysis will analyse these groups as "adopters" and "rejecters" of technology without considering other factors. Results suggest that FD-MUs of the "traditional routine" group tend not to make changes. The reasons they give include i) the technology available is only suitable for good natural resources or ii) there is no offer of technology by research institutions for marginal lands as the shallow basaltic soils. The important

[1] 78.6 percent of the FD-MUs of this group are interested in latest technology and 85.7 percent are located in Agroecozone II.

[2] 86.4 percent of the FD-MUs of this group are not interested in latest technology and 70.5 percent are located in Agroecozone I.

implication is that the transmission of the same technological package, information and knowledge for all the three Types of FD-MUs does not appear to be adequate. As was presented in this Chapter, different extension methods need to be applied to the different FD-MUs' "recommendation domains". Different recommendation domains would require different extension and research methods.

Adjusting extension programmes and methods to farmer needs

As presented earlier, the requirements of the three "recommendations domains" would be targeted by extension in different ways. The different types of farms need to be integrated to the process as active sources of knowledge and learning. FD-MUs are learning systems where different sources of information and knowledge are integrated and blended in a different way in order to support decisions. Therefore, the requirements of "external" information through extension programmes and methods ought to be different.

Participatory methods would be more useful for the farmers of Group 1, who are not adopting the technological package developed by INIA. It can be suggested that the methods of extension and information delivery need to emphasise the need to involve farmers in the process of determination of research priorities, adaptive research in pilot farms, and strengthening experimentation and RPK acquisition. Models can help to encapsulate the RPK rules and to develop tools for the more effective control of the pilot farms.

In the case of FD-MUs of Groups 2 and 3, the RPK acquisition is also important. However, the mechanisms for information delivery to these type of farmers could be different. As suggested earlier, FD-MUs of Group 2 would be better targeted by offering new technology associated with public extension services and credit. In this case, people from public advisory services are used as the main “information digestors”. In the case of Group 3, the delivery of information can be better targeted by involving the different “information digestors” associated with the different subsystems in the process.

In summary, not only the farmer needs to be considered when the delivery mechanisms and data transmission for each group are developed, but also the “information digestors” and “sounding boards” associated to each “recommendation domain”.

Facilitating knowledge and information exchange

Despite the differences among the groups, the FD-MUs base their decisions mainly on rural people’s knowledge. The thesis’ results show that the main mechanisms for communicating farming practices is based on the exchange of ideas with other farmers (35.4 percent) and on the exchange of ideas with advisers (26.6 percent) (Appendix 7; Addendum Table 7.35). Extensionists need to act not just as information deliverers, but in close connection with FD-MUs to identify real problems and needs, and to acquire useful rural people’s knowledge and rules to facilitate knowledge and information exchange among FD-MUs of the same recommendation domain.

Evolutionary understanding of FD-MUs behaviour to changes.

The thesis has pointed-out that an important aspect to bear in mind is the response in FD-MUs behaviour in reaction to change. Three main Types of FD-MUs have been identified in the basaltic region. Results suggest that FD-MUs dissatisfied with their achievements are more willing to change (Chapters 7 and 8). FD-MUs that feel satisfied with the levels of results achieved will continue with the same routine plan. The attitude to change and new technology among them is significant and the degree of dissatisfaction is an important explanatory factor (Chapter 4). Therefore a possible rule for change can be described as:

> **IF** the level of achievements of the FD-MU is similar to that of past years, and no state of dissatisfaction is generated within the FD-MU, **THEN** continue applying the "traditional" management plan, **ELSE** look for new alternatives to change.

This is reinforced by thesis findings about the behaviour of the FD-MUs groups: "traditional routine" FD-MUs are generally satisfied with the system they are farming, respond to changes using the old routines and heuristic rules; "innovative sustainable" FD-MUs, that are mainly dissatisfied with the system respond to changes by gradually improving the farm, investing and adopting technology; and "entrepreneurial imitators" respond to changes by introducing major strategic changes in selected parts of the production system in response to a state of dissatisfaction produced by major external changes (Chapter 8). As was presented in the thesis, evolution can be explained by a mix of "gradualist" and "punctuated" changes. As described in Chapter 8, FD-MUs, when confronted with a critical event, respond in different ways; "traditional routine" FD-MUs have a passive attitude to change; "innovative sustainable" and "entrepreneurial imitators" have an active attitude to change but they have different behaviour as a consequence of their evolutionary process. The "innovative sustainable" are proactive, will introduce change gradually and, therefore, will be better prepared to control and cope with external or internal events, whilst "entrepreneurial imitators" introduce partial major strategic changes in their production systems only when they are enforced to do so. That is, they alternate between states of activity and routine.

The important implication is that the behaviour to be expected from each group of FD-MUs is rooted in their pattern of decision-making evolution. In some cases, decision-making in response to change is introduced gradually and in others, it is "punctuated".

Another implication for extension is that FD-MUs are diverse and dynamic and technical change needs to be considered as a continuous process of evolution. The way to explore adequate solutions is through close inter-relationships between the FD-MU and the extensionist, where the extensionist acts in a double function:

receiving and acquiring information, knowledge and problems from FD-MUs and transmitting information knowledge and problems acquired through different sources such as other FD-MUs and research.

Variations in the propensity to changes

The thesis has analysed the FD-MUs response when faced with some critical internal and external event that forces the system to move into atypical conditions (Chapter 8, Section 8.2). Results reinforce Rosenberg (cited by Dossi 1988) about change being induced by technological bottlenecks and scarcities. Despite the fact that the FD-MU Types show a different pattern of response to changes, ("traditional routine" passive, "innovative sustainable" proactive, "entrepreneurial imitators", reactive) it was during the drought when FD-MUs on the whole, were more prone to change. Therefore, it is important for extension agencies to have clear ideas about how to induce change at those particular moments, when FD-MUs are more receptive.

Integrating the Agricultural Knowledge Information System

The search for new ideas for the development of a more effective integration and use of the Agricultural Knowledge Information System in Uruguay is crucial. As presented in Chapter 4, there are several institutions and people that are sources of information and knowledge in the agricultural sector. It would appear that a first step to improve decision making advice is to establish better co-operation between farmers, industry, extension and research in order use, in a more effective way, local rural people's knowledge and scientific knowledge for the support of decision making. Farmer populations are heterogeneous as are the dynamics developed to solve specific problems. Different family histories, agroecological, socio-economic, cultural, ethical, and demographic conditions generate different patterns of FD-MUs, DSS and farming systems. These differences are indicated by the different combination of resources, main practices used, levels of production and patterns of household consumption. Information and knowledge delivery mechanisms can be improved by an effective and active participation of all the people involved in the process.

9.3. Testing the hypotheses developed from the study

At the end of Chapter 5, a set of hypotheses were developed to be tested with the thesis results and analysis. Chapters 6, 7 and 8 presented the methodology and discussion of results. Here, a summary of these findings related to the hypotheses and sub-hypotheses is presented.

9.3.1. Hypotheses and sub-hypotheses related to information and decision support systems

The hypotheses and sub-hypotheses related to information and decision support systems are:

H 1. It is possible to understand better the decision-making process of extensive livestock farmers of the basaltic soils of Uruguay.

The sub-hypothesis related are:

SH 1.1. There is an implicit decision support system on all farms mainly developed by family experience (grandfather, father, mother, etc.), household, kinship, social interrelationships, own experience and rural people's knowledge.

SH 1.2. There is an information system built within the framework of the farmer decision support system and rural people's knowledge where informal information is the main input in order to support and assist the making of decisions.

To test these hypotheses, the strategy was to gather information through a general survey on the basaltic area and through case studies. The methodology involved statistical procedures oriented to define the main features of the population of FD-MUs, mainly based on quantitative information together with in depth case studies, to obtain mainly qualitative information (Chapter 7 and 8). Despite the relative few cases selected, the combination of survey and case study permitted the following preliminary conclusions that need to be confirmed with further research.

- The unit of resource allocation at farm level is the FD-MU (Chapters 7 and 8, Sections 7.7 and 8.5).

• The FD-MU is comprised by the decision maker (usually the farmer) and "trusted people". The "trusted people" are members of the family and/or other people that deserve the decision-maker's trust (Chapters 7 and 8, Sections 7.7 and 8.5).

• The FD-MU is the platform of decision making at farm level (Chapter 8, Section 8.5).

• These platforms of decision making are strongly affected by demographic features of the farmer, the family, and "trusted people" such as: traditions, beliefs, social, cultural and ethical values which are, in part, products of the evolution of the FD-MU (Chapter 8, Section 8.5).

• Within the FD-MU different natural decision support subsystems can be identified related to specific areas of management such as: pasture, animals, soils, economical and financial (Chapter 7, Section 7.7).

• These decision support systems appear to be the product of the FD-MU adaptation process to cope with external and internal changes and therefore have different complexity according to the FD-MU analysed.

• Rural people's knowledge and information play an important role in farm decision making (Chapter 8, Section 8.5, Table 8.5).

The information presented above suggests that for the data analysed sub-hypotheses 1 and 2 hold. However, other studies are necessary to arrive to more conclusive results.

9.3.2. Hypothesis related to FD-MUs behaviours in farming decision making

The following hypothesis was formulated related to the development of a conceptual model of behaviour:

H 2. It is possible to identify behavioral Types of FD-MUs and depict "models" of the "natural" decision support system structure in farmer's decision-making.

The sub-hypothesis related are:

SH 2.1. It is possible to identify and classify groups of farmers by features in the decision making process in order to target better the research and extension complex to bring about change.

SH.2.2. Farmers do not modify the existing farm system until forced by some change.

The thesis has described the methodology used in order to explore the possibility of identifying some FD-MU's behaviour Types regarding to changes in the basaltic area and therefore, to test these hypotheses and sub-hypotheses. The methodology was based on the analysis of a survey and cases studies. Using multivariate statistical methods, it was possible to classify FD-MUs into three statistically different FD-MUs behavioural groups. On the basis of the mean and the mode of the information analysed for each group, it was possible to delineate the main features of the FD-MUs Types (Chapter 7, Section 7.5). According to the behaviour in response to changes, the Types found in the thesis were nominated as: “Traditional routine”, “Innovative sustainable” and “Entrepreneurial imitators”. Information on the main characteristics, level of adaptation and response to change of the different FD-MU Types was presented in the thesis. So were the different strategies for information search, knowledge acquisition, processing and analysis used to support decisions for the FD-MUs Types described. To validate the classification and therefore the FD-MU Types obtained, results where submitted to discriminant analysis (Chapter 7, Section 7.6). Once the classification process was successfully validated, a description of the farm decision making unit in the three Types was elaborated. The analysis of the FD-MUs behaviour Types and decision making unit description allowed also for the development of a general “model” of decision support in farm decision making units (Chapter 7, Section 7.9). The “model” suggests that the “natural” decision support systems operate basically by way of “trusted people”. A case study was carried-out to determine the different informative functions of the “trusted people” as “information digestors” and “sounding boards”. Based on the case study analysis, the decision maker and “trusted people” appear to be the decision making platform at farm level (Röling 1994). Thesis results also suggest that this platform of decision making can be viewed as nested groups of decision support sub-systems. The complexity of these platforms appears to be the main difference among the FD-MU’s “natural” decision support systems. For example, for Type 1, the FD-MU appears to be comprised by a very simple platform of decision making where decision support mainly involves the decision maker and "sounding boards", whilst for Type 2 and 3, where the complexity of the systems increase, the decision making "platform" is split into different decision support sub-systems such as pasture, animal, economic management, etc. and the complexity within each subsystem also appears to increase (number of "trusted people" involved in each subsystems and type of "trusted people": "information digestors" and "sounding boards"). According to the information analysed, it may be suggested that the general "model" of the farm decision making structure developed in Chapter 7 can be applied to the three Types found. However, further research would be necessary to confirm the general model for each type. It would appear that the main difference among Types is:

- how the different information (formal and informal) and knowledge sources (scientific and rural people's knowledge) are blended to make decisions and
- the complexity of the decision support subsystems.

The different procedures and analysis developed in the thesis allow the study to :

- classify FD-MUs according to their behaviour and "natural" DSSs (Chapter 7, Sections 7.3 and 7.4).
- Identify and describe the three main Types of behaviour to changes. These Types are statistically different and represent the FD-MU groups found in the basaltic region (Chapter 7, Section 7.5; Appendix 7 and Addendum).

- Validate this classification using discriminant analysis (Chapter 7, Section 7.6).
- Depict a general "model" of the decision support system of the FD-MU (Chapter 7, Section 7.9).
- Select a case study for each group in order to develop an in-depth case study focusing on the analysis of the FD-MUs behaviour towards technical change and to "natural" decision support system features (Chapter 8, Section 8.2 and 8.3).

The thesis has demonstrated that it is possible to classify FD-MUs according to their behaviour and DSS in the basaltic region of Uruguay. The results indicate that these groups of farmers have similar behaviour and "natural" DSSs. The Types and "model" described in the thesis can be utilised to enhance the relevance of research and extension actions and to assist policy makers. Understanding the reasons for behaviour within the groups, and how expectancies for the future are developed and used for supporting decisions (Chapter 8, Section 8.4 and 8.5) in the three Types of FD-MUs can be used to channel and receive information for extension and research institutions.

The results also show that FD-MUs have different response behaviours to change. As presented, the majority of the FD-MUs do not introduce strategic actions until a substantial internal or external change takes place (Chapter 8, Section 8.4).

It appears that FD-MUs may be responsive to change somewhat in the same way as biological systems. When changes occur in the environment, the biological response is the adaptation of individuals or “mutants” [3] who can cope with the new situation. For FD-MUs facing change, it was found that some disappear (leave farming), some "mutate", that is introduce change in a “gradual” or “punctuated” form (FD-MUs of groups 2 and 3) and some others “survive” maintaining the old and traditional routines (FD-MUs of group 1) trying to find ways to cope with the situation. The results appear to confirm that technical change is induced by “bottlenecks”, scarcities or abundance of critical inputs, change in relative prices and changes in the demand growth (Rosenberg cited by Dossi 1988) (Chapter 8, Section 8.4).

The analysis of the survey information presented in the Thesis shows that 27 percent of the FD-MUs do not change until a big change takes place (“Entrepreneurial imitators”), 18 percent introduce changes gradually (“Innovative sustainable”) and 55 percent maintain the traditional routines and tend not to change (“Traditional routine”). However, the case studies confirm that the only group of FD-MUs that introduce major strategic changes in the existing farm system are the “Entrepreneurial imitators” and then, not until a substantial event takes place. So, the information analysed allows the conclusion that farmers do not introduce major strategic changes in their production systems until a big change takes place.

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[3] *According to the Neo-Darwinist theory "mutations" may be interpreted as more or less accidental trial-error-gambits, and "natural selection" as one way of controlling them by error-elimination (page 54 Evolutionary Epistemology, Theory of Rationality, and the Sociology of Knowledge.)*

Therefore, with the methodology described (Chapter 6, Section 6.2) it was possible to identify three different FD-MU behaviours towards changes and to develop a general conceptual "model" of the structure of the natural DSS (Chapter 7). On the basis of the information generated from the Types, an in-depth case study was carried out for each of the Types in order to analyse FD-MUs behaviour to changes. The information suggests that technical change is induced by bottleneck and constraints, and no major strategic changes are introduced until a substantial external or internal change takes place. Therefore, information analysis suggests that sub-hypothesis **SH2.1** and **SH2.2**. hold true

9.3.3. Hypothesis related to INIA efficiency

H 3. Using such "models" it is possible to define more appropriate "recommendation domains" for research and extension activities.

The sub-hypothesis related is:

SH 3.1. INIA is less efficient than it could be in satisfying and targeting farmers' needs.

As presented in the Thesis, despite the fact that INIA has integrated farmers on to the Board of the Institution, new and more participatory and holistic approaches appear to be necessary in order to build-in rural people's knowledge in order to better target real FD-MU problems (Chapter 2, Sections 2.4 and 2.5.). Information presented in Chapters, 2, 3 and 4 shows that INIA has been allocating resources in order to increase system productivity mainly looking at:

- biophysical productivity increase
- economic margins increase
- high production varieties
- export commodities
- an average farmer

The TOT approach is still dominant with the assumption that technology is scale neutral. The results show that 55 percent of farmers in the basaltic region are not interested in INIA's technology and results and only 18 percent are high adopters (Chapter 7, Section 7.5). These figures are clear enough to show that there is an opportunity to increase INIA's activities.

Some researchers at INIA are now conscious of the need to change to a more holistic view of technical change where socio-economic, cultural and environmental issues are considered. As presented, INIA is still driving most of the actions to an average farmer. This policy has not been very effective to the farming population (Chapter 2, Section 2.3.5). It has already been emphasised that most new technology is biased to FD-MU with the largest farms, located in the best agroecozones, and who are better educated, with entrepreneurial behaviour and who are financially able to accept the costs of new technology (Uquillas 1994). The information presented suggests that classifying FD-MUs according to their behaviour and "natural" decision support systems into "recommendation domains" along the lines suggested in this thesis, can help to define research priorities to homogeneous groups of FD-MUs (Williams 1994). Using "recommendation domains" as identified in the Thesis, to target research and extension actions and elicit rural people's knowledge may improve the efficiency of INIA's research. The classical TOT model, as used at INIA, provides a narrow and static view of the process in technical change, directed to an "average farmer" and that only accepts scientific and formal knowledge as valid. The above considerations suggest that the hypothesis 5 holds true.

9.4. Further Research

This research represents only one more attempt to better understand the decision making process at farm level in order to assist policy makers, researchers and extensionsts to improve the formulation of their work. The work has two limitations that need to be considered:

• The study was carried out for farms larger than 200 hectares. Complementary work for smaller farms would be of general interest.

• The in-depth case study, has provided detailed information for only one case in each class. Increasing the number of cases selected in each group could contribute with further insights about the features of each group. A suggested approach is to take one FD-MU at each extreme of the group and one near the centroid. In this way it may be possible to analyse how similar or dissimilar the FD-MUs are within the groups.

Further research is necessary in order to confirm the general "model" of the structure of the "natural" decision support systems at farm level for each of the different Types analysed. Also, it would be desirable to study and define different strategies in order to integrate the different sources of information and knowledge in the agricultural sector. Research is needed in order to identify the best way to improve the interfaces between the different levels of decision making (policy, research, extension and farm). Scientific and rural people's knowledge needs to be available to all those interested in rural development. In this way, it may be possible to use the agricultural knowledge system to move agricultural practices towards socio-economic equity and environmental sustainability.

Another issue for further research that comes up from the survey and cases analysis is related to education and technical change at farm level. It seems that higher degrees of propensity to technical change are associated to medium levels of education rather than to higher University degrees. There could be two main reasons to support this:

1) Farmers with University degrees can obtain better household income working as professionals and, therefore, farming work could be seen as a secondary activity where most of the decisions and the monitoring are delegated.

2) In order to attend schools farmers need to spend long time living in the cities thus being exposed to the urban values and style of life, which could change their satisfactors to those more associated with urban rather than with farm achievements.

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Appendix 6 (Chapter 6)

Appendix 6.A.

6.1. Main Livestock Agroecozones:

I. Cattle and sheep raising on shallow basaltic soils (Artigas, Salto, Tacuarembó and Paysandú).

II. Cattle and sheep raising on other basaltic soils (Artigas and Salto).

III. Cattle and sheep raising on sandy soils (Tacuarembó, Rivera and Paysandú).

IV. Cattle and sheep raising on crystalline soils in the centre of the country (Flores, Florida and Durazno).

V. Cattle and sheep raising on crystalline soils in the east of the country (Lavalleja, Rocha and Maldonado).

VI. Cattle and sheep raising on the Yaguari soils, in the north-east of the country (Rivera and Cerro Largo).

6.1.1. Agroecozone I

Sample sites.

Basaltic shallow soils: 1,733,673 hectares.

Main group of soils: Cuchilla de Haedo - Paso de los Toros [CH-PT], 1,011,523 hectares, Queguay Chico [Qch], 634,158 hectares and Massoller [Ma] 87,992 hectares.

95 % of the land devoted to Extensive Livestock Production Systems.

Fertility: Medium to high.

Draught risk: very high.

Stoniness: moderate to strong.

Natural pasture production: 2.8 tons of/Dry Matter/hectare[1]

Table 6.A.1. Sample sites on basaltic shallow soils.

Department	Police section	Census sector (sample sites)
Artigas	3	2
	12	2
	10	3
	11	1
Salto	13	1
	12	1 and 2
Tacuarembó	3	1
Paysandú	10	2

[1]Estimated by Berretta (1996) based on the average of 15 years of pasture production (1980-1994).

6.1.2. Agroecozone II

Sample sites.

Other basaltic soils: 2,239,820 hectares.

Main group of soils: Itapebí-Tres Arboles [I-TA], 1,256,516 hectares, Curtinas [Cu], 805,781 hectares, Cuaro [Ca], 87,992 and Baygorria [Ba], 89,531 .

93 % of the land devoted to Extensive Livestock Production Systems.

Fertility: Very high.

Draught risk: medium to high.

Stoniness: light to moderate.

Natural pasture production: 4.1 tons of Dry Matter/hectare

Table.6.A.2. Sample sites on other basaltic soils.

Department	Police section	Census sector (sample site)
Salto	7	3
	6	2 and 3
	9	1 and 2
	16	1
Artigas	12	1
	4	1 and 2
	6	1 and 2

Appendix 6.B.

6.2. Sample Design Criteria.

The criteria used for sample design is associated with the previously used by Equipos. In order to test the quality of Equipos sample and determine a size of the sample that can assure a good confidence level with the available resources, some variables were chosen. The criteria used was to test some key variables against DICOSE and agricultural census data in order to have some idea about consistency on the sample data.

6.2.1. Farm area.

Most of the studies identify this one as a key indicator of economic firm size. There are other possibilities for size such as total of bovine cattle, total of sheep, and total livestock including horses. The data allowed us to calculate the correlation coefficients among farm area and total of bovine cattle, total of sheep, and stocking rate. The Pearson correlation coefficient found was 0.87, 0.85 and 0.94 respectively. This values indicates that there is a strong linear association between the pairs of variables studied. Due to this significant meaningful correlation among surface and these variables was opted to follow the criterion used by Equipos namely, to use surface as the variable to estimate farm's size.

6.2.2. Ownership.

Another aspect studied in the definition of the sample was the relationship between ownership of the land and number of farmers. In this case we tested the level of the variables in the Equipos Sample, DICOSE and the level in the Census. The level found in the sample for each group of owners, tenants, and other precarious forms of ownership of the land was consistent with the census data and DICOSE.

6.2.3. Pasture Improvement level.

The level of pasture improvement as an indicator of technology level was also tested. According to the extension agents, it is necessary to have more than a 12 % of pasture improved area to have an impact at the production level. This indicator was defined as the number of farms with more 12% of the total surface used with pasture improvements. The level found was similar on both the sample and the total population of the census.

6.3. Sampling size.

The sample size was determined on the basis of a stratified random sampling. This means that prior to the selection of the cases, the sampling frame is divided into strata. This strata represents factors that influences the features to being measured. In this way, a simple random or systematic random sample is selected within each stratum and the sample size can be reduced. The sample size is affected by the confidence and the error. The error depends on the standard deviation. One way to reduce the error is by dividing the population into strata. Stratifying the precision of the sample can be improved because only the within-stratum variation contributes to the standard error of the mean. According to Cochran (1977) much of the benefit will be obtained when using two or three strata and no more than six. To determine the sample size the number of farmers to be interviewed by stratum is used the Neyman criteria were $n_i = n\, N_iS_i / \sum N_iS_i$, where the relevant factors in the size of the stratum are:

N_i = Original size of the stratum.

S_i^2 = Stratum variance

n_i = sample size.

6.4. Questionnaire

The questionnaire was built in order to identify what are the main components used for the farmers in the basaltic area when they made decisions. **The original questionnaire was developed in Spanish. A translated version to English, can be provided by the author if required.** It was necessary to identify the appropriate questions to obtain information related to demographic, economic, decisional, situational, managerial and behavioural factors, such as:

• Different levels of decision, tactical and Strategic levels and the relation with the control decisions. How is managed the relation between objectives in the short, medium and long term.

• Whether the base of decisions is formally planned. Also what is the consideration used by the farmer for decide between high, middle and low strategy to achieve the little and big objectives in the short, medium and long term (e.g. Chapter 5, Section 5.2.2 and Chapter 8, Section 8.5, Table 8.5).

• Identify if the main objective who drives the decision making process is related with farm or off-farm activities.

• What is the relation between big objectives and decisions and the little objectives and decisions take day by day.

• How time and the age of the farmer and family affect the decisions making.

• How the different objectives are prioritised by the decision maker and what the criteria used for develop this prioritisation, such as:

- Farmer objectives.
- Family objectives.
- Farm objectives.
- Individual objectives.
- Social objectives.

Appendix 6.C.

Table 6.1. Age of the farmer and consort

Age	Farmer N°	Farmer %	Wife or consort N°	Wife or consort %
20-39	21	27.1	25	30.0
40-49	16	19.8	20	24.7
+ 50	44	54.1	26	32.0
No Wife or consort	0	0.0	10	12.3
Total	81	100.0	81	100.0

Table 6.2 Age of the youngest child

Age	N°	%
1-9	26	32.1
10-19	14	17.3
20-29	23	28.4
+30	15	18.5
No Child	3	3.7
Total	81	100.0

Table 6.3 Transference of property

	N°	%
Family relationship	54	66.6
Purchase and tenancy	21	26.0
Manager	6	7.4
Total	81	100.0

Table 6.4 Formal education of the farmer, consort and oldest child

Formal education	Farmer N°	Farmer %	Wife or consort N°	Wife or consort %	Oldest child N°	Oldest child %
No Formal education	0	0.0	0	0.0	7	9.3
Primary incomplete	12	15.0	5	7.0	10	13.3
P.complete and H.S. incomplete	10	12.5	10	14.1	14	18.7
High school complete	19	23.8	27	38.0	10	13.3
Polytech and others	21	26.3	23	32.5	26	34.7
Complete University	19	23.5	6	8.4	8	10.7
Total	81	100.0	71	100.0	75[2]	100.0

[2]Four child death

Table 6.5. Farmer experience, number of children and size of the family

	Mean	Max.	Min.	Std. dev.
Years farming	25.0	60	2	13.6
Years farming this farm	23.9	55	2	12.0
Number of children	2.7	9	0	1.6
Size of the family	4.6	11	1	1.7

Table 6.6. Farmer marital status

Marital Status	N°	%
Married	68	84.0
Single	5	6.2
Divorced	5	6.2
Widow	3	3.6
Total	81	100.0

Table 6.7. Ownership

Ownership	N°	%
Individual ownership	47	58.0
Partnership	34	42.0
Total	81	100.0

Table 6.8. Farmer sex

Sex	N°	%
Male	78	96.3
Female	3	3.7
Total	81	100.0

Table 6.9. Farmer residence place

	Farmer		Family	
Residence place	N°	%	N°	%
The farm	9	11.1	5	6.2
The farm and in a city near the farm	16	19.8	4	4.9
The farm and in a city far from the farm	1	1.2	1	1.2
Off the farm	55	67.9	71	87.7
Total	81	100.0	81	100.0

Table 6.10. Farmers thinking on retirement

	Farmer	
Thinking on retirement	N°	%
Yes	7	8.6
No	74	91.4
Total	81	100.0

Table 6.11. Household on and off farm income

	Work on the farm			Income	
				On-farm	Off-farm
	N°	Total	%	%	%
Farmer	81	81	100.0	78.0	22.0
Wife or consort	15	71	21.1	34.0	66.0
Child 1	17	75	22.7	58.0	32.0
Child 2	12	69	17.4	92.0	8.0
Others	6			43.0	57.0

Table 6.12. Type of farmer off-farm activity

Off-farm activity	N°	%
No off-farm activity.	47	58.0
Others	16	19.8
Professional	11	13.6
Rural auctioneer	7	8.6
Total	81	100.0

Table 6.13 Farmer reasons to have an off farm activity

Reasons	N°	%
No off farm activity	47	58.0
Both works are complementary	14	18.4
Is necessary to afford the expenses	10	12.3
To diversify income	10	12.3
Total	81	100.0

Table 6.14. Farmers' on and off-farm activities and age of the farmer

	Age of the farmer							
	20-39		40-49		+50		Total	
Do you have an off farm activity	N°	%	N°	%	N°	%	N°	%
Yes	13	16.0	8	9.9	13	16.0	34	42.0
No	8	9.9	8	9.9	31	38.3	47	58.0
Total	21	25.9	16	19.8	44	54.3	81	100.0

(χ^2=6.64, 2 d.f.; P=0.04, minimum expected frequency=6.72)

Table 6.15. Farmers' on and off-farm activities and formal education

	Off-farm activity					
	Yes		No		Total	
Formal education	N°	%	N°	%	No	%
Primary incomplete	1	1.2	11	13.6	12	14.8
P.complete and H.S. incomplete	3	3.7	7	8.6	10	12.3
High school complete	10	12.3	9	11.1	19	23.5
Polytech and others	5	6.2	16	19.8	21	25.9
Complete University	15	18.5	4	4.9	19	23.5
Total	34	42.0	47	58.0	81	100.0

(χ^2=20.56, d.f.=4; P=0.00, minimum expected frequency = 4.20)

Table 6.16. Size of the farm and age of the farmer

	Age of the farmer							
	20-39		40-49		+50		Total	
Size of the farm	N°	%	N°	%	N°	%	N°	%
200-999	5	6.2	1	1.2	25	30.9	31	38.3
1000-2499	5	6.2	9	11.1	9	11.1	23	28.4
+ 2500	11	13.6	6	7.4	10	12.3	27	33.3
Total	21	25.9	16	19.8	44	54.3	81	100.0

(χ^2=18.74, 4 d.f.; P=0.00, minimum expected frequency=4.54)

Table 6.17. Size of the farm and farmer formal education

	Size							
	200-999		1000-2499		+ 2500		Total	
Formal education	N°	%	N°	%	N°	%	No	%
Primary incomplete	9	11.1	2	2.5	1	1.2	12	14.8
P.complete and H.S. incomplete	4	4.9	3	3.7	3	3.7	10	12.3
High school complete	9	11.1	4	4.9	6	7.4	19	23.5
Polytech and others	5	6.2	8	9.9	8	9.9	21	25.9
Complete University	4	4.9	6	7.4	9	11.1	19	23.5
Total	31	38.3	23	28.4	27	33.3	81	100.0

(χ^2=12.55, d.f.=8; P=0.13, minimum expected frequency= 2.84)

Table 6.18. Age of the farmer and formal education

	Age of the farmer							
	20-39		40-49		+50		Total	
Formal education	N°	%	N°	%	N°	%	N°	%
Primary incomplete	0	0.0	0	0.0	12	14.8	12	14.8
P.complete and H.S. incomplete	1	1.2	2	2.5	7	8.6	10	12.3
High school complete	7	8.6	4	4.9	8	9.9	19	23.5
Polytech and others	5	6.2	5	6.2	11	13.6	21	25.9
Complete University	8	9.9	5	6.2	6	7.4	19	23.5
Total	21	25.9	16	19.8	44	54.3	81	100.0

(χ^2=17.30, 8 d.f.; P=0.03, minimum expected frequency=1.98)

Table 6.19. Ownership and age of the farmer

	Age of the farmer							
	20-39		40-49		+50		Total	
Types of ownership	N°	%	N°	%	N°	%	N°	%
Individual ownership	3	3.7	9	11.1	35	43.2	47	58.0
Partnership	18	22.2	7	8.6	9	11.1	34	42.0
Total	21	25.9	16	19.8	44	54.3	81	100.0

(χ^2=24.88, 2 d.f.; P=0.00, minimum expected frequency=6.72)

Table 6.20. Ownership and farmer formal education

	Ownership					
	Individual		Partnership		Total	
Formal education	N°	%	N°	%	N°	%
Primary incomplete	11	13.6	1	1.2	12	14.8
P.complete and H.S. incomplete	7	8.6	3	3.7	10	12.3
High school complete	7	8.6	12	14.8	19	23.5
Polytech and others	13	27.7	8	23.5	21	25.9
Complete University	9	11.1	10	12.3	19	23.5
Total	47	58.0	34	42.0	81	100.0

(χ^2=10.68, 4 d.f.; P=0.03, minimum expected frequency=4.19)

Table 6.21. Property transfer and age of the farmer

	Age of the farmer							
	20-39		40-49		+50		Total	
Types of transfer	N°	%	N°	%	N°	%	N°	%
Family relationship	19	23.5	9	11.1	26	32.1	64	66.7
Purchase and tenancy	1	1.2	2	2.5	18	22.2	21	25.9
Manager	1	1.2	5	6.2	0	0	6	7.4
Total	21	25.9	16	19.8	44	54.3	81	100

(χ^2=26.71, 4 d.f.; P=0.00, minimum expected frequency=1.19)

Table 6.22. Property transfer and farmer formal education

	Types of transfer							
	Purchase and tenancy		Family relationship		Manager		Total	
Formal education	N°	%	N°	%	N°	%	N°	%
Primary incomplete	8	9.9	4	4.9	0	0.0	12	14.8
P.complete and H.S. incomplete	4	4.1	5	6.2	1	1.2	10	12.3
High school complete	2	2.5	16	19.8	1	1.2	19	23.5
Polytech and others	4	4.9	16	19.8	1	1.2	21	25.9
Complete University	3	3.7	13	16.0	3	3.7	19	23.5
Total	21	25.9	54	66.7	6	7.4	81	100.0

(χ^2=18.01, d.f.=8; P=0.02, minimum expected frequency= 0.74)

Table 6.23. Farmers' interest on farm diversification and age of the farmer

	Age of the farmer							
	20-39		40-49		+50		Total	
Planning changes	N°	%	N°	%	N°	%	N°	%
Yes	11	13.6	8	9.9	19	23.5	38	46.9
No	10	12.3	8	9.9	25	30.9	43	53.1
Total	21	25.9	16	19.8	44	54.3	81	100.0

(χ^2=0.56, 2 d.f.; P=0.76, minimum expected frequency=7.51)

Table 6.24. Farmers' interested on farm diversification and farmer formal education

	Interested					
	Yes		No		Total	
Formal education	N°	%	N°	%	N°	%
Primary incomplete	4	4.9	8	9.9	12	14.8
P.complete and H.S. incomplete	5	6.2	5	6.2	10	12.3
High school complete	10	12.3	9	11.1	19	23.5
Polytech and others	9	11.1	12	14.8	21	25.9
Complete University	10	12.3	9	11.1	19	23.5
Total	38	46.9	43	53.1	81	100.0

(χ^2=1.56, d.f.=4; P=0.81, minimum expected frequency= 0.74)

Table 6.25. Planning changes on beef cattle production and age of the farmer

	Age of the farmer							
	20-39		40-49		+50		Total	
Planning changes	N°	%	N°	%	N°	%	N°	%
Yes	11	14.1	6	7.7	10	12.8	27	34.6
No	10	12.8	10	12.8	31	39.7	51	65.4
Total	21	26.9	16	20.5	41	52.6	78	100

(χ^2=4.88, 2 d.f.; P=0.09, minimum expected frequency=5.54)

Table 6.26. Planning changes on beef cattle production and farmer formal education

	Planning changes					
	Yes		No		Total	
Formal education	N°	%	N°	%	N°	%
Primary incomplete	2	2.6	10	12.8	12	15.4
P.complete and H.S. incomplete	1	1.3	7	9.0	8	10.3
High school complete	5	6.4	14	17.9	19	24.4
Polytech and others	9	11.5	11	14.1	20	25.6
Complete University	10	12.8	9	11.5	19	24.4
Total	27	34.6	51	65.4	78	100.0

(χ^2=7.69, d.f.=2; P=0.10, minimum expected frequency= 2.77)

Table 6.27. Planning changes on sheep production and age of the farmer

	Age of the farmer							
	20-39		40-49		+50		Total	
Planning changes	N°	%	N°	%	N°	%	N°	%
Yes	9	11.5	3	3.8	9	11.5	21	26.9
No	12	15.4	12	15.4	33	42.3	57	73.1
Total	21	26.9	15	19.2	42	53.8	78	100.0

(χ^2=3.72, 2 d.f.; P=0.15, minimum expected frequency=4.04)

Table 6.28. Planning changes on sheep production and farmer formal education

	Planning changes					
	Yes		No		Total	
Formal education	N°	%	N°	%	N°	%
Primary incomplete	0	0.0	11	14.1	11	14.1
P.complete and H.S. incomplete	2	2.6	7	9.0	9	11.5
High school complete	4	5.1	15	19.2	19	24.4
Polytech and others	9	11.5	11	14.1	20	25.6
Complete University	6	7.7	13	16.7	19	24.4
Total	21	26.9	57	73.1	78	100.0

(χ^2=8.02, d.f.=4; P=0.9, minimum expected frequency= 2.42)

Table 6.29. Main sources of information and age of the farmer

	Age of the farmer							
	20-39		40-49		+50		Total	
Source of information	N°	%	N°	%	N°	%	N°	%
Rural officers and clerks	5	6.2	2	2.5	14	17.3	21	25.9
Family	5	6.2	2	2.5	11	13.6	18	22.2
Advisers	5	6.2	3	3.7	8	9.9	16	19.8
Mass media	2	2.5	3	3.7	9	11.1	14	17.3
Farm records	2	2.5	4	4.9	1	1.2	7	8.6
Farmers groups or associations	2	2.5	2	2.5	1	1.2	5	6.2
Total	21	25.9	16	19.8	44	54.3	81	100.0

(χ^2=13.3, d.f.=10; P=0.20, minimum expected frequency=0.99)

Table 6.30. Farmers search field for prices to decide upon a big purchase and age of the farmer

	Age of the farmer							
	20-39		40-49		+50		Total	
Search field	N°	%	N°	%	N°	%	N°	%
Purchase in the usual supplier	14	17.3	5	6.2	31	38.3	50	61.7
Look in the local suppliers	6	7.4	7	8.6	13	16.0	26	32.1
National suppliers	1	1.2	4	4.9	0	0.0	5	6.2
Total	21	25.9	16	19.8	44	54.3	81	100.0

(χ^2=15.85, d.f.=4; P=0.00, minimum expected frequency=0.99)

Table 6.31. Records kept directly by farmers and age of the farmer[3]

	Age of the farmer							
	20-39		40-49		+50		Total	
Records	N°	%	N°	%	N°	%	N°	%
Expenses and income records	13	16.0	8	9.9	16	19.8	37	45.7
DICOSE compulsory records	2	2.5	1	1.2	16	19.8	19	23.5
Climate records	3	3.7	4	4.9	9	11.1	16	19.8
Production records	3	3.7	1	1.2	1	1.2	5	6.2
Others	0	0	2	2.5	2	2.5	4	4.9
Total	21	25.9	16	19.8	44	54.3	81	100.0

(χ^2=15.77, d.f.=8; P=0.04, minimum expected frequency=0.79)

Table 6.32. Main reasons to kept records and age of the farmer

	Age of the farmer							
	20-39		40-49		+50		Total	
Reasons	N°	%	N°	%	N°	%	N°	%
To manage the farm	11	13.8	9	11.3	13	16.3	33	40.7
Because it is compulsory	6	7.5	4	5.0	23	27.5	33	40.7
To have papers in order	4	5.0	3	3.8	8	10.0	15	18.5
Total	21	25.9	16	19.8	44	54.3	81	100.0

(χ^2=6.18, d.f.=4; P=0.19, minimum expected frequency=3.00)

Table 6.33. Main reasons to kept records and farmer formal education

	Reasons							
	To manage the farm		Because it is compulsory		Just to have papers in order		Total	
Formal education	N°	%	N°	%	N°	%	N°	%
Primary incomplete	1	1.2	10	12.3	1	1.2	12	14.8
P.complete and H.S. incomplete	3	3.7	4	4.9	3	3.7	10	12.3
High school complete	5	6.2	9	11.1	5	6.2	19	23.5
Polytech and others	9	11.1	8	9.9	4	4.9	21	25.9
Complete University	15	18.5	2	2.5	2	2.5	19	23.5
Total	33	40.7	33	40.7	15	18.5	81	100.0

χ^2=23.69, 8 d.f.; P=0.00, minimum expected frequency=1.85)

[3] Famers were asked to rank order records. Questionnaire question 59.

Table 6.34. Farmers' main use of the records and age of the farmer

	Age of the farmer							
	20-39		40-49		+50		Total	
Records main use	N°	%	N°	%	N°	%	N°	%
To know farm situation	8	9.9	3	3.7	12	14.8	23	28.4
To take investment decisions	3	3.7	4	4.9	4	4.9	11	13.6
Other	7	8.6	8	9.9	9	11.1	24	29.6
Do not use	3	3.7	1	1.2	19	23.5	23	28.4
Total	21	25.9	16	19.8	44	54.3	81	100.0

(χ^2=14.65, d.f.=6; P=0.02, minimum expected frequency=2.17)

Table 6.35. Farmers' main use of the records and farmer formal education

	Reasons									
	To know farm situation		To take investment decisions		Other farm activities		Do not use		Total	
Formal education	N°	%	N°	%	N°	%	N°	%	N°	%
Primary incomplete	2	2.5	0	0	1	1.2	9	11.1	12	14.8
P.complete and H.S. incomplete	1	1.2	3	3.7	3	3.7	3	3.7	10	12.3
High school complete	4	4.9	3	3.7	6	7.4	6	7.4	19	23.5
Polytech and others	6	7.4	5	6.2	6	7.4	4	4.9	21	25.9
Complete University	10	12.3	0	0	8	9.9	1	1.2	19	23.5
Total	23	28.4	11	13.6	24	29.6	23	28.4	81	100.0

(χ^2=30.30, 12 d.f.; P=0.00, minimum expected frequency=1.36)

Table 6.36. Farmers' production costs knowledge and age of the farmer

	Age of the farmer							
	20-39		40-49		+50		Total	
Production cost knowledge	N°	%	N°	%	N°	%	N°	%
Yes	9	11.1	5	6.2	10	12.3	24	29.3
No	12	14.8	11	13.6	34	42.0	57	70.4
Total	21	25.9	16	19.8	44	54.3	81	100.0

(χ^2=2.79, d.f.=2; P=0.25, minimum expected frequency= 4.74)

Table 6.37. Farmers' production costs knowledge and formal education

	Production cost knowledge					
	Yes		No		Total	
Formal education	N°	%	N°	%	No	%
Primary incomplete	1	1.2	11	13.6	12	14.8
P.complete and H.S. incomplete	3	3.7	7	8.6	10	12.3
High school complete	4	4.9	15	18.5	19	23.5
Polytech and others	7	8.6	14	17.3	21	25.9
Complete University	9	11.1	10	12.3	19	23.5
Total	24	29.6	57	70.4	81	100.0

(χ^2=6.28, d.f.=4; P=0.18, minimum expected frequency= 2.96)

Table 6.38. Farmers' production costs knowledge by agroecozone and age of the farmer

	Production cost knowledge					
	Yes		No		Total	
Agroecozone	N°	%	N°	%	No	%
Shallow basaltic soils	8	9.9	34	42.0	42	51.9
Other basaltic soils	16	19.8	23	28.4	39	48.1
Total	24	29.6	57	70.4	81	100.0

(χ^2=4.68, d.f.=1; P=0.03, minimum expected frequency= 11.56)

Table 6.39. Farmers' production costs by agroecozone

	Production cost in American dollars				
Agroecozone	No	Mean	Std dv	Minimum	Maximum
Shallow basaltic soils	7	28.1	10.7	17.0	43.0
Other basaltic soils	15	30.0	8.8	18.0	45.0
Total	22	29.4	9.2	17.0	45.0

Table 6.40. Farmers' production costs by size of the farm

	Production cost in American dollars				
Size	No	Mean	Std dv	Minimum	Maximum
200 - 999 has	5	26.2	8.0	17.0	33.0
1000-2499 has	5	29.4	7.8	18.0	40.0
+ 2500 has	12	30.8	10.4	17.0	45.0
Total	22	29.4	9.2	17.0	45.0

Table 6.41. Farmers' key information for support decisions and age of the farmer

	Age of the farmer							
	20-39		40-49		+50		Total	
Information	N°	%	N°	%	N°	%	N°	%
Market information	10	12.3	6	7.4	20	24.7	36	44.4
Farm records	4	4.9	3	3.7	12	14.8	19	23.5
Farm records and market information	5	6.2	6	7.4	7	8.6	18	22.2
Other	2	2.5	1	1.2	5	6.2	8	9.9
Total	21	25.9	16	19.8	44	54.3	81	100.0

(χ^2=3.63, d.f.=6; P=0.72, minimum expected frequency= 1.58)

Table 6.42. Farmers' key information for support decisions and farmer formal education

	Key information for support decisions									
	Farm records		Market information		Farm records and market information		Other		Total	
Formal education	N°	%	N°	%	N°	%	N°	%	N°	%
Primary incomplete	2	2.5	6	7.4	1	1.2	3	3.7	12	14.8
P.complete and H.S. incomplete	2	2.5	5	6.2	1	1.2	2	2.5	10	12.3
High school complete	2	2.5	13	16.0	4	4.9	0	0.0	19	23.5
Polytech and others	9	11.1	8	9.9	3	3.7	1	1.2	21	25.9
Complete University	4	4.9	4	4.9	9	11.1	2	2.5	19	23.5
Total	19	23.5	36	44.4	18	22.2	8	9.9	81	100.0

(χ^2=24.18, 12 d.f.; P=0.02, minimum expected frequency=0.99)

Table 6.43. Farmers' type of information for support decisions and age of the farmer

	Age of the farmer							
	20-39		40-49		+50		Total	
Type of information	N°	%	N°	%	N°	%	N°	%
Mainly Formal	4	4.9	5	6.2	8	9.9	17	21.0
Formal and Informal	6	7.4	6	7.4	8	9.9	20	24.7
Mainly Informal	11	13.6	5	6.2	28	34.6	44	54.3
Total	21	25.9	16	19.8	44	54.3	81	100.0

(χ^2=5.24, d.f.=4; P=0.26, minimum expected frequency= 3.36)

Table 6.44. Farmers' type of information for support decisions and farmer formal education

	Type of information used for support decisions							
	Mainly Formal		Formal and Informal		Mainly Informal		Total	
Formal education	N°	%	N°	%	N°	%	N°	%
Primary incomplete	0	0.0	1	1.2	11	13.6	12	14.8
P.complete and H.S. incomplete	1	1.2	1	1.2	8	9.9	10	12.3
High school complete	4	4.9	3	3.7	12	14.8	19	23.5
Polytech and others	6	7.4	6	7.4	9	11.1	21	25.9
Complete University	6	7.4	9	11.1	4	4.9	19	23.5
Total	17	21.0	20	24.7	44	54.3	81	100.0

(χ^2=20.51, d.f.=8; P=0.01, minimum expected frequency= 2.01)

Table 6.45. Differential use of informal or formal information according to the type of decision and age of the farmer

	Age of the farmer							
	20-39		40-49		+50		Total	
Different use of information	N°	%	N°	%	N°	%	N°	%
Yes	13	16.0	10	12.3	14	17.3	37	45.7
No	8	9.9	6	7.4	30	37.0	44	54.3
Total	21	25.9	16	19.8	44	54.3	81	100.0

(χ^2=7.46, d.f.=2; P=0.02, minimum expected frequency= 7.31)

Table 6.46. Differential use of formal or informal information according to the type of decision and farmer formal education

	Different use of information					
	Yes		No		Total	
Formal education	N°	%	N°	%	No	%
Primary Incomplete	2	2.5	10	12.3	12	14.8
P. Complete & Incomplete H.School	3	3.7	7	8.6	10	12.3
Complete High School	4	4.9	15	18.5	19	23.5
Polytech and others	12	14.8	9	11.1	21	25.9
Complete University	16	19.8	3	3.7	19	23.5
Total	37	45.7	44	54.3	81	100.0

(χ^2=22.19, d.f.=4; P=0.00, minimum expected frequency= 4.57)

Table 6.47. Main use of formal information and age of the farmer

	Age of the farmer							
	20-39		40-49		+50		Total	
Use	N°	%	N°	%	N°	%	N°	%
Planning and Investments	5	6.2	7	8.6	3	3.7	15	18.5
Credits enquires	3	3.7	2	2.5	2	2.5	7	8.6
Accounting	1	1.2	1	1.2	3	3.7	5	6.2
Production decisions	1	1.2	0	0.0	4	4.9	5	6.2
Do not use formal	8	9.9	6	7.4	30	37.0	44	54.3
Total	21	25.9	16	19.8	44	54.3	81	100.0

(χ^2=19.56, d.f.=10; P=0.03, minimum expected frequency=0.99)

Table 6.48. Farmers' use of intuition or analysis to support decisions and age of the farmer

	Age of the farmer							
	20-39		40-49		+50		Total	
Type of information	N°	%	N°	%	N°	%	N°	%
Mainly Intuition	6	7.4	4	4.9	20	24.7	30	37.0
Intuition and Analysis	10	12.3	8	9.9	21	25.9	39	48.1
Mainly Analysis	5	6.2	4	4.9	3	3.7	12	14.8
Total	21	25.9	16	19.8	44	54.3	81	100.0

(χ^2=3.64, d.f.=6; P=0.73, minimum expected frequency=1.58)

Table 6.49. Farmers' use of intuition or analysis to support decisions and farmer formal education

	Type of information used for support decisions							
	Mainly Intuition		Intuition and Analysis		Mainly Analysis		Total	
Formal education	N°	%	N°	%	N°	%	N°	%
Primary incomplete	8	9.9	4	4.9	0	0.0	12	14.8
P.complete and H.S. incomplete	5	6.2	5	6.2	0	0.0	10	12.3
High school complete	6	7.4	9	11.1	4	4.9	19	23.5
Polytech and others	9	11.1	10	12.3	2	2.5	21	25.9
Complete University	2	2.5	11	13.6	6	7.4	19	23.5
Total	30	37.0	39	48.1	12	14.8	81	100.0

(χ^2=15.94, d.f.=8; P=0.04, minimum expected frequency=1.48)

Table 6.50. Farmers' decision that requires more analysis and age of the farmer

	Age of the farmer							
	20-39		40-49		+50		Total	
Decision	N°	%	N°	%	N°	%	N°	%
Investments	9	11.1	10	12.3	15	18.5	34	42.0
Credits	5	6.2	0	0.0	10	12.3	15	18.5
Commodity changes	1	1.2	3	3.7	4	4.9	8	9.9
Other	6	7.4	3	3.7	15	18.5	24	29.6
Total	21	25.9	16	19.8	44	54.3	81	100.0

(χ^2=8.76, d.f.=6; P=0.19, minimum expected frequency=1.58)

Table 6.51. Farmers' decision that they think they need advice and age of the farmer

	Age of the farmer							
	20-39		40-49		+50		Total	
Decision	N°	%	N°	%	N°	%	N°	%
Production and technical	9	11.1	6	7.4	28	34.6	43	53.1
Economic and financial	8	9.9	6	7.4	16	19.8	30	37.0
Commodity changes	4	4.9	4	4.9	0	0.0	8	9.9
Total	21	25.9	16	19.8	44	54.3	81	100.0

(χ^2=11.92, d.f.=4; P=0.02, minimum expected frequency= 1.58)

Table 6.52. Decisions where farmers' think they need to concentrate their effort to have success and age of the farmer

	Age of the farmer							
	20-39		40-49		+50		Total	
Decision	N°	%	N°	%	N°	%	N°	%
Production and technical	13	16.0	12	14.8	29	35.8	54	66.7
Economic and financial	7	8.6	2	2.5	15	18.5	24	29.6
Commodity changes	1	1.2	2	2.5	0	0.0	3	3.7
Total	21	25.9	16	19.8	44	54.3	81	100.0

(χ^2=7.25, d.f.=4; P=0.12, minimum expected frequency=0.59)

Table 6.53. Farmers' that own a computer and age of the farmer

	Age of the farmer							
	20-39		40-49		+50		Total	
Do you have a computer ?	N°	%	N°	%	N°	%	N°	%
Yes	9	11.1	4	4.9	4	4.9	17	21.0
No	12	14.8	12	14.8	40	49.4	64	79.0
Total	21	25.9	16	19.8	44	54.3	81	100.0

(χ^2=9.97, d.f.=2; P=0.01, minimum expected frequency=3.36)

Table 6.54. Farmers' that own a computer and farmer formal education

	Own a computer					
	Yes		No		Total	
Formal education	N°	%	N°	%	N°	%
Primary incomplete	0	0.0	12	14.8	12	14.8
P.complete and H.S. incomplete	1	1.2	9	11.1	10	12.3
High school complete	6	7.4	13	16.0	19	23.5
Polytech and others	2	2.5	19	23.5	21	25.9
Complete University	8	9.9	11	13.6	19	23.5
Total	17	21.0	64	79.0	81	100.0

(χ^2=11.97, 4 d.f.; P=0.02, minimum expected frequency=2.01)

Table 6.55. Farmers' main reasons to do not have a computer and age of the farmer

	Age of the farmer							
	20-39		40-49		+50		Total	
Reasons	N°	%	N°	%	N°	%	N°	%
Lack of understanding and no interest	3	3.7	5	6.2	18	22.2	26	32.1
It is not justified	3	3.7	3	3.7	9	11.1	15	18.5
Have other priorities	5	6.2	2	2.5	6	7.4	13	16.0
Considered in the future	1	1.2	1	1.2	4	4.9	6	7.4
The adviser need to have one	0	0.0	1	1.2	3	3.7	4	4.9
Already have a computer	9	11.1	4	4.9	4	4.9	17	21.0
Total	21	25.9	16	19.8	44	54.3	81	100.0

(χ^2=14.19, d.f.=10; P=0.16, minimum expected frequency=0.79)

Table 6.56. Use of computers on farm and age of the farmer

	Age of the farmer							
	20-39		40-49		+50		Total	
Computer use	N°	%	N°	%	N°	%	N°	%
Use on the farm	7	8.6	3	3.7	1	1.2	11	13.6
Not use on the farm	2	2.5	1	1.2	3	3.7	6	7.4
Do not have a computer	12	14.8	12	14.8	40	49.4	64	79.0
Total	21	25.9	16	19.8	44	54.3	81	100.0

(χ^2=12.76, d.f.=4; P=0.01, minimum expected frequency=1.19)

Table 6.57. Main applications on the farm and age of the farmer

	Age of the farmer							
	20-39		40-49		+50		Total	
Main application	N°	%	N°	%	N°	%	N°	%
Economic and financial analysis	5	6.2	2	2.5	4	4.9	11	13.6
Total	5	6.2	2	2.5	4	4.9	11	13.6

Table 6.58. Decision to farm the current system by actors involved and weight

Actors	N°	%
Farmer	44.1	54.5
Father	26.6	32.9
Wife or consort	3.5	4.3
Partners	2.8	3.4
Relatives	1.8	2.2
Son	1.4	1.7
Advisers	0.8	1.0
Total	81.0	100.0

Table 6.59. Day by day decisions by actors involved and weight

Actors	N°	%
Farmer	55.0	67.9
Clerks	7.1	8.8
Manager	5.7	7.0
Son	4.3	5.3
Wife or consort	2.9	3.5
Partner	1.8	2.3
Father	1.7	2.2
Relatives and Friends	1.6	2.0
Advisers	0.9	1.1
Total	81.0	100.0

Table 6.60. Decisions on animals and pastures by actors involved and weight

Actors	N°	%
Farmer	54.9	67.8
Son	8.9	11.0
Foreman	7.9	9.7
Advisers	3.4	4.1
Manager	2.6	3.2
Partner	1.7	2.1
Father	1.1	1.4
Wife or consort	0.6	0.7
Total	81.0	100.0

Table 6.61. Decisions to buy animals by actors involved and weight

Actors	N°	%
Farmer	54.9	75.3
Son	7.1	9.7
Father	3.0	4.2
Manager	2.5	3.4
Wife or consort	2.1	2.9
Partner	1.8	2.5
Advisers	1.0	1.4
Relatives and Friends	0.3	0.4
Foreman	0.2	0.3
Total	73.0	100.0
Farmer buying animals	73.0	90.0

Table 6.62. Decisions to sell farm products by actors involved and weight

Actors	N°	%
Farmer	61.1	75.4
Son	8.1	9.9
Father	3.3	4.1
Wife or consort	2.5	3.1
Manager	2.5	3.1
Partner	2.3	2.9
Relatives and Friends	0.6	0.7
Advisers	0.4	0.5
Foreman	0.2	0.3
Total	81.0	100.0

Table 6.63. Investment decisions by actors involved and weight

Actors	N°	%
Farmer	58.8	72.6
Son	7.0	8.6
Father	3.8	4.7
Wife or consort	3.0	3.7
Partner	2.4	3.0
Advisers	2.0	2.5
Foreman	1.7	2.1
Manager	1.3	1.6
Relatives and Friends	0.9	1.1
Total	81.0	100.0

Table 6.64. Acceptance of your ideas from other farmers and age of the farmer

	Age of the farmer							
	20-39		40-49		+50		Total	
Answer	N°	%	N°	%	N°	%	N°	%
Yes	18	22.2	13	16.0	32	39.5	63	77.8
No	3	3.7	3	3.7	12	14.8	18	22.2
Total	21	25.9	16	19.8	44	54.3	81	100.0

(χ^2=1.53, 2 d.f.; P=0.47, minimum expected frequency=3.56)

Table 6.65. Aquisition of ideas from other farmers and farmer formal education

	Answer					
	Yes		No		Total	
Formal education	N°	%	N°	%	No	%
Primary Incomplete	7	8.6	5	6.2	12	14.8
P. Complete & Incomplete H.School	7	8.6	3	3.7	10	12.3
Complete High School	16	19.8	3	3.7	19	23.5
Polytech and others	15	18.5	6	7.4	21	25.9
Complete University	18	22.2	1	1.2	19	23.5
Total	63	77.8	18	22.2	81	100.0

(χ^2=7.08, 4 d.f.; P=0.13, minimum expected frequency=2.22)

Table 6.66. Acceptance of your ideas by other farmers and age of the farmer

	Age of the farmer							
	20-39		40-49		+50		Total	
Answer	N°	%	N°	%	N°	%	N°	%
Yes	17	21.0	10	12.3	27	33.3	54	66.7
Not	4	4.9	6	7.4	17	21.0	27	33.3
Total	21	25.9	16	19.8	44	54.3	81	100.0

(χ^2=2.61, 2 d.f.; P=0.27, minimum expected frequency=5.33)

Table 6.67. Acceptance of your ideas by other farmers and farmer formal education

	Answer					
	Yes		No		Total	
Formal education	N°	%	N°	%	No	%
Primary Incomplete	8	9.9	4	4.9	12	14.8
P. Complete & Incomplete H.School	4	4.9	6	7.4	10	12.3
Complete High School	13	16.0	6	7.4	19	23.5
Polytech and others	13	16.0	8	9.9	21	25.9
Complete University	16	19.8	3	3.7	19	23.5
Total	54	66.7	27	33.3	81	100.0

(χ^2=6.07, 4 d.f.; P=0.19, minimum expected frequency=3.33)

Table 6.68. Farmers more useful communication source of farming practices and age of the farmer

	Age of the farmer							
	20-39		40-49		+50		Total	
Answer	N°	%	N°	%	N°	%	N°	%
Ideas exchange with other farmers	3	3.7	6	7.4	20	24.7	29	35.8
Ideas exchange with advisers	7	8.6	4	4.9	11	13.6	22	27.2
Technical meetings	3	3.7	2	2.5	2	2.5	7	8.6
Field days	5	6.2	0	0	2	2.5	7	8.6
Others	3	3.7	4	4.9	9	11.1	16	19.8
Total	21	25.9	16	19.8	44	54.3	81	100.0

(χ^2=14.55, 8 d.f.; P=0.07, minimum expected frequency=1.38)

Table 6.69. Farm organisation and age of the farmer

	Age of the farmer							
	20-39		40-49		+50		Total	
Farm organisation	N°	%	N°	%	N°	%	N°	%
Familiar organisation	10	12.3	7	8.6	35	43.2	52	64.2
Family enterprise	5	6.2	4	4.9	6	7.4	15	18.5
Mainly entrepreneurial	6	7.4	5	6.2	3	3.7	14	17.3
Total	21	25.9	16	19.8	44	54.3	81	100.0

(χ^2=10.94, 4 d.f.; P=0.03, minimum expected frequency=2.77)

Table 6.70. Farm organisation and farmer formal education

	Farm organisation							
	Familiar organisation		Family enterprise		Mainly entrepreneurial		Total	
Formal education	N°	%	N°	%	N°	%	N°	%
Primary incomplete	11	13.6	1	1.2	0	0.0	12	14.8
P.complete and H.S. incomplete	8	9.9	1	1.2	1	1.2	10	12.3
High school complete	10	12.3	7	8.6	2	2.5	19	23.5
Polytech and others	16	19.8	3	3.7	2	2.5	21	25.9
Complete University	7	8.6	3	3.7	9	11.1	19	23.5
Total	52	64.2	15	18.5	14	17.3	81	100.0

(χ^2=23.23, 8 d.f.; P=0.00, minimum expected frequency=1.73)

Table 6.71. Farm organisation farmers' think is better for farming and age of the farmer

	Age of the farmer							
	20-39		40-49		+50		Total	
Answer	N°	%	N°	%	N°	%	N°	%
Familiar organisation	8	9.9	4	4.9	27	33.3	39	48.1
Family enterprise	3	3.7	4	4.9	9	11.1	16	19.8
Mainly entrepreneurial	10	12.3	8	9.9	8	9.9	26	32.1
Total	21	25.9	16	19.8	44	54.3	81	100.0

(χ^2=10.19, 4 d.f.; P=0.04, minimum expected frequency=3.16)

Table 6.72. Farm organisation farmers' think is better for farming and farmer formal education

	Farm organisation							
	Familiar organisation		Family enterprise		Mainly entrepreneurial		Total	
Formal education	N°	%	N°	%	N°	%	N°	%
Primary incomplete	10	12.3	1	1.2	1	1.2	12	14.8
P.complete and H.S. incomplete	6	7.4	1	1.2	3	3.7	10	12.3
High school complete	9	11.1	7	8.6	3	3.7	19	23.5
Polytech and others	9	11.1	4	4.9	8	9.9	21	25.9
Complete University	5	6.2	3	3.7	11	13.6	19	23.5
Total	39	48.1	16	19.8	26	32.1	81	100.0

(χ^2=17.49, 8 d.f.; P=0.02, minimum expected frequency=1.98)

Table 6.73. Frequency of programming achieves and age of the farmer

	Age of the farmer							
	20-39		40-49		+50		Total	
Programming farm activities	N°	%	N°	%	N°	%	N°	%
Always	2	2.5	2	2.5	6	7.4	10	12.3
Almost always	13	16.0	9	11.1	16	19.8	38	46.9
Almost never	6	7.4	5	6.2	22	27.2	33	40.7
Total	21	25.9	16	19.8	44	54.3	81	100.0

(χ^2=4.59, 4 d.f.; P=0.33, minimum expected frequency=1.98)

Table 6.74. Frequency of programming achieves and farmer formal education

	Programming farm activities							
	Always		Almost always		Almost never		Total	
Formal education	N°	%	N°	%	N°	%	N°	%
Primary incomplete	0	0.0	4	4.9	8	9.9	12	14.8
P.complete and H.S. incomplete	2	2.5	2	2.5	6	7.4	10	12.3
High school complete	2	2.5	8	9.9	9	11.1	19	23.5
Polytech and others	3	3.7	10	12.3	8	9.9	21	25.9
Complete University	3	3.7	14	17.3	2	2.5	19	23.5
Total	10	12.3	38	46.9	33	40.7	81	100.0

(χ^2=14.66, 8 d.f.; P=0.07, minimum expected frequency=1.24)

Table 6.75. Period of programming achieves and age of the farmer

	Age of the farmer							
	20-39		40-49		+50		Total	
Period of programming farm activities	N°	%	N°	%	N°	%	N°	%
No programming	3	3.7	3	3.7	17	21.0	23	28.4
Programming for 1-6 months	11	13.6	6	7.4	8	9.9	25	30.9
Programming mainly for 1 year	7	8.6	7	8.6	19	23.5	33	40.7
Total	21	25.9	16	19.8	44	54.3	81	100.0

(χ^2=9.68, 4 d.f.; P=0.05, minimum expected frequency=4.54)

Table 6.76. Period of programming achieves and farmer formal education

	Period of programming farm activities							
	No programming		Programming for 1-6 months		Programming mainly for 1 year		Total	
Formal education	N°	%	N°	%	N°	%	N°	%
Primary incomplete	6	7.4	0	0.0	6	7.4	12	14.8
P.complete and H.S. incomplete	5	6.2	2	2.5	3	3.7	10	12.3
High school complete	6	7.4	10	12.3	3	3.7	19	23.5
Polytech and others	6	7.4	6	7.4	9	11.1	21	25.9
Complete University	0	0.0	7	8.6	12	14.8	19	23.5
Total	23	28.4	25	30.9	33	40.7	81	100.0

(χ^2=22.14, 8 d.f.; P=0.00, minimum expected frequency=2.84)

Table 6.77. Farm by type of soils

Zone	N°	%
Shallow soils	42	52.0
Deep soils	39	48.0
Total	81	100.0

Table 6.78. Farmer preferred working system

	Age of the farmer							
	20-39		40-49		+50		Total	
	N°	%	N°	%	N°	%	N°	%
Beef cattle	0.0	0.0	3	3.7	6	7.4	9	11.1
Sheep	3	3.7	0	0.0	5	6.2	8	9.9
Cattle and sheep together	18	22.2	13	16.0	33	40.7	64	79.0
Total	21	25.9	16	19.8	44	54.3	81	100.0

(χ^2=5.73, 4 d.f.; P=0.22, minimum expected frequency=1.58)

Table 6.79. Main activity on beef cattle production and farmer formal education

	Cow-calf		Complete Cycle		Finishing		Other		Total	
Formal education	N°	%	N°	%	N°	%	N°	%	No	%
Primary Incomplete	9	11.1	2	2.5	1	1.2	0	0.0	12	14.8
P. Complete & Incomplete H.School	0	0.0	4	4.9	3	3.7	3	3.7	10	12.0
Complete High School	8	9.9	4	4.9	2	2.5	5	6.2	19	23.5
Polytech and others	5	6.2	11	13.6	2	2.5	3	3.7	21	25.9
Complete University	5	6.2	9	11.1	1	1.2	4	4.9	19	23.5
Total	27	33.3	30	37.0	9	11.1	15	18.5	81	100.

(χ^2=23.20, d.f.=12; P=0.03, minimum expected frequency= 1.11)

Table 6.80. Main activity on sheep production and farmer formal education

Formal education	Sheep-lamb breeding N°	%	Complete Cycle N°	%	Total No	%
Primary Incomplete	7	9.0	4	5.1	11	14.1
P. Complete & Incomplete H.School	1	1.3	9	11.5	10	12.8
Complete High School	4	5.1	14	17.9	18	23.1
Polytech and others	4	5.1	16	20.5	20	25.6
Complete University	4	5.1	15	19.2	19	24.4
Total	20	25.6	58	74.4	78	100.0

(χ^2=10.27, d.f.=4; P=0.04, minimum expected frequency= 2.56)

Table 6.81. Production system indicators

System indicators	**Mean**	**Std.dev.**
Size of the farm (hectares)	2789	4900
Paddocks		
Number	9.9	9.79
Size of paddocks		
Hectares	282	
Total animal units		
Animals Units	2073	3665
Stocking rate		
Sheep stocking rate (animals/ha)	0.43	0.22
Cattle stocking rate/ha (animals/ha)	0.35	0.16
Horses stocking rate/ha (animals/ha)	0.03	0.03
Total stocking rate/ha (animals/ha)	0.81	0.22
Cattle		
Total heads	1352	2412
Sheep		
Total heads	5351	9616
Ratio		
Sheep/cattle	5.86	4.35
Weaning cattle percentage		
	51%	60
Weaning sheep percentage		
	65%	72
Improved pastures	3.10%	4.98
Crops land	3.53%	9.03
Wool production		
Kg/ha	7.41	7.09
Production costs		
Average (American dollars)	29.42	9.19
Non-Family labour		
Permanent labourers/farm	6.00	12.09
Days of seasonal labour/ farm	130	206

Table 6.82. Number of paddocks

Number of paddocks	N°	%
1-3	14	17.2
4-6	28	34.6
7-9	11	13.6
+10	28	34.6
Total	81	100.0

Table 6.83. Use of electric fence and age of the farmer

	Age of the farmer							
	20-39		40-49		+50		Total	
Use of electric fence	N°	%	N°	%	N°	%	N°	%
Yes	7	8.6	3	3.7	11	13.6	21	25.9
No	14	17.3	13	16.0	33	40.7	60	74.1
Total	21	25.9	16	19.8	44	54.3	81	100.0

(χ^2=1.05, d.f.=2; P=0.59, minimum expected frequency= 4.15)

Table 6.84. Use of electric fence and farmer formal education

	Use electric fence					
	Yes		No		Total	
Formal education	N°	%	N°	%	No	%
Primary Incomplete	2	2.5	10	12.3	12	14.8
P. Complete & Incomplete H.School	3	3.7	7	8.6	10	12.3
Complete High School	4	4.9	15	18.5	19	23.5
Polytech and others	6	7.4	15	18.5	21	25.9
Complete University	6	7.4	13	16.0	19	23.5
Total	21	25.9	60	74.1	81	100.0

(χ^2=1.25, d.f.=4; P=0.86, minimum expected frequency= 2.59)

Table 6.85. Winter supplementation with grain and age of the farmer

	Age of the farmer							
	20-39		40-49		+50		Total	
Grain feeding in winter	N°	%	N°	%	N°	%	N°	%
Yes	1	1.2	1	1.2	2	2.5	4	4.9
No	9	11.1	9	11.1	24	29.6	42	51.9
Only during the drought	11	13.6	6	7.4	18	22.2	35	43.2
Total	21	25.9	16	19.8	44	54.3	81	100.0

(χ^2=1.10, d.f.=4; P=0.89, minimum expected frequency= 0.79)

Table 6.86. Farmer use of the best pasture to animals finishing and age of the farmer

	Age of the farmer							
	20-39		40-49		+50		Total	
Use best pasture for finishing	N°	%	N°	%	N°	%	N°	%
Yes	18	22.2	12	14.8	28	34.6	58	71.6
No	3	3.7	4	4.9	16	19.8	23	28.4
Total	21	25.9	16	19.8	44	54.3	81	100.0

(χ^2=3.52, 2 d.f.; P=0.17, minimum expected frequency=4.54)

Table 6.87. Farmers' use of the best pasture to animal finishing and farmer formal education

	Use best pasture for finishing					
	Yes		No		Total	
Formal education	N°	%	N°	%	No	%
Primary Incomplete	7	8.6	5	6.2	12	14.8
P. Complete & Incomplete H.School	8	9.9	2	2.5	10	12.3
Complete High School	14	17.3	5	6.2	19	23.5
Polytech and others	15	18.5	6	7.4	21	25.9
Complete University	14	17.3	5	6.2	19	23.5
Total	58	71.6	23	28.4	81	100.0

(χ^2=1.47, 4 d.f.; P=0.83, minimum expected frequency=2.84)

Table 6.88. Farmers' main objective for pastures and age of the farmer

	Age of the farmer							
	20-39		40-49		+50		Total	
Objective	N°	%	N°	%	N°	%	N°	%
Feed animals	14	17.3	9	11.1	19	23.5	42	51.9
Maintain natural grassland	3	3.7	3	3.7	10	12.3	16	19.8
Improve the soil	3	3.7	1	1.2	5	6.2	9	11.1
Others	1	1.2	3	3.7	10	12.3	14	17.3
Total	21	25.9	16	19.8	44	54.3	81	100.0

(χ^2=5.32, 6 d.f.; P=0.50, minimum expected frequency=1.78)

Table 6.89. Farmers' base rule for quality pasture determination and age of the farmer

	Age of the farmer							
	20-39		40-49		+50		Total	
Rule based on:	N°	%	N°	%	N°	%	N°	%
Animal weight increase	13	16.0	7	8.6	19	23.5	39	48.1
Legume availability	3	3.7	1	1.2	8	9.9	12	14.8
Pasture availability	2	2.5	4	4.9	6	7.4	12	14.8
Others	3	3.7	4	4.9	9	13.6	18	22.2
Total	21	25.9	16	19.8	42	54.3	81	100.0

(χ^2=4.61, 6 d.f.; P=0.59, minimum expected frequency=2.37)

Table 6.90. Farmers' perception of main seasonal bottle neck for animals and pasture production and age of the farmer

	Age of the farmer							
	20-39		40-49		+50		Total	
Period	N°	%	N°	%	N°	%	N°	%
Winter	14	17.3	15	18.5	33	40.7	62	76.5
Summer	7	8.6	1	1.2	11	13.6	19	23.5
Total	21	25.9	16	19.8	44	54.3	81	100.0

(χ^2=3.84, 2 d.f.; P=0.15, minimum expected frequency=3.75)

Table 6.91. Farmers' strategy to cope with the identified seasonal bottle neck for animals and pasture production and age of the farmer

	Age of the farmer							
	20-39		40-49		+50		Total	
Strategy	N°	%	N°	%	N°	%	N°	%
Pasture improvements	8	9.9	3	3.7	12	14.8	23	28.4
Agist	2	2.5	3	3.7	8	9.9	13	16.0
Sell animals	2	2.5	3	3.7	7	8.6	12	14.8
Forage crops	1	1.2	0	0.0	5	6.2	6	7.4
Do nothing	7	8.6	3	3.7	10	12.3	20	24.7
Others	1	1.2	4	4.9	2	2.5	7	8.6
Total	21	25.9	16	19.8	44	54.3	81	100.0

(χ^2=12.01, 10 d.f.; P=0.28, minimum expected frequency=1.18)

Table 6.92. Farmers considering to include a new practice for animal feeding in the future and age of the farmer

	Age of the farmer							
	20-39		40-49		+50		Total	
Considering a new practice	N°	%	N°	%	N°	%	N°	%
Yes	17	21.0	11	13.6	27	33.3	55	67.9
No	2	2.5	4	4.9	16	19.8	22	27.2
I do not know	2	2.5	1	1.2	1	1.2	4	4.9
Total	21	25.9	16	19.8	44	54.3	81	100.0

(χ^2=6.19, 4 d.f.; P=0.19, minimum expected frequency=0.79)

Table 6.93. Farmers' rule base for pasture management control and age of the farmer

	Age of the farmer							
	20-39		40-49		+50		Total	
Rule based on:	N°	%	N°	%	N°	%	N°	%
Pasture height	11	13.6	8	9.9	30	37.0	49	60.5
Volume of green pasture	7	8.6	7	8.6	6	7.4	20	24.7
Pasture colour	1	1.2	0	0.0	4	4.9	5	6.2
Other	2	2.5	1	1.2	4	4.9	7	8.6
Total	21	25.9	16	19.8	44	54.3	81	100.0

(χ^2=7.91, 6 d.f.; P=0.24, minimum expected frequency=0.99)

Table 6.94. Farmers' rule base for animals management control and age of the farmer

	Age of the farmer							
	20-39		40-49		+50		Total	
Rule based on:	N°	%	N°	%	N°	%	N°	%
Score condition	19	23.5	14	17.3	40	49.4	73	90.1
Scales	2	2.5	1	1.2	1	1.2	4	4.9
Others	0	0.0	1	1.2	3	3.6	4	4.9
Total	21	25.9	16	19.8	44	54.3	81	100.0

(χ^2=3.00, 4 d.f.; P=0.55, minimum expected frequency=0.79)

Table 6.95. Frequency of counting the animals and age of the farmer

	Age of the farmer							
	20-39		40-49		+50		Total	
Frequency	N°	%	N°	%	N°	%	N°	%
Every month	11	13.6	7	8.6	26	32.1	44	54.3
Every two month	4	4.9	3	3.7	5	6.2	12	14.8
More than two month	6	7.4	6	7.4	13	16.0	25	30.9
Total	21	25.9	16	19.8	44	54.3	81	100.0

(χ^2=1.59, 4 d.f.; P=0.81, minimum expected frequency=2.37)

Table. 6.96. Frequency of counting the animals and farmer formal education

	Use of advise							
	Every month		Every two month		More than two month		Total	
Formal education	N°	%	N°	%	No	%	No	%
Primary Incomplete	8	9.9	1	1.2	3	3.7	12	14.8
P. Complete & Incomplete H.School	5	6.2	0	0.0	5	6.2	10	12.3
Complete High School	10	12.3	3	3.7	6	7.4	19	23.5
Polytech and others	10	12.3	6	7.4	5	6.2	21	25.9
Complete University	11	13.6	2	2.5	6	7.4	19	23.5
Total	44	54.3	12	14.8	25	30.9	81	100.0

(χ^2=7.02, 8 d.f.; P=0.53, minimum expected frequency=1.48)

Table 6.97. Use of credit and age of the farmer

	Age of the farmer							
	20-39		40-49		+50		Total	
Use of credit	N°	%	N°	%	N°	%	N°	%
Yes	6	7.4	8	9.9	16	19.8	30	37.0
No	15	18.5	8	9.9	28	34.6	51	63.0
Total	21	25.9	16	19.8	44	54.3	81	100.0

(χ^2=1.80, d.f.=2; P=0.40, minimum expected frequency= 5.93)

Table 6.98. Use of credit and farmer formal education

	Use of credit					
	Yes		No		Total	
Formal education	N°	%	N°	%	No	%
Primary Incomplete	3	3.7	9	11.1	12	14.8
P. Complete & Incomplete H.School	3	3.7	7	8.6	10	12.3
Complete High School	6	7.4	13	16.0	19	23.5
Polytech and others	11	13.6	10	12.3	21	25.9
Complete University	7	8.6	12	14.8	19	23.5
Total	30	37.0	51	63.0	81	100.0

(χ^2=3.32, d.f.=4; P=0.51, minimum expected frequency= 3.70)

Table 6.99. Labour as a constraint to adopt technology and age of the farmer

	Age of the farmer							
	20-39		40-49		+50		Total	
Labour is a constraint	N°	%	N°	%	N°	%	N°	%
Yes	12	15.0	10	12..3	31	38.8	53	65.4
No	9	11.3	6	7.5	13	16.3	28	35.0
Total	21	26.3	15	18.8	44	55.0	81	100.0

(χ^2=1.19, 2 d.f.; P=0.55, minimum expected frequency=5.53)

Table 6.100. Labour as a constraint to adopt technology and farmer formal education

	Labour is a constraint					
	Yes		No		Total	
Formal education	N°	%	N°	%	N°	%
Primary incomplete	6	7.5	6	7.5	12	15.0
P.complete and H.S. incompletel	6	7.5	4	5.0	10	12.5
High school complete	12	15.0	7	8.8	19	23.8
Polytech and others	15	18.8	6	7.5	21	26.3
Complete University	14	17.3	5	6.3	19	23.5
Total	53	65.4	28	34.6	81	100.0

(χ^2=2.34, d.f.=4; P=0.67, minimum expected frequency= 3.50)

Table 6.101. Farmer use of advise and age of the farmer

	Age of the farmer							
	20-39		40-49		+50		Total	
Use of advise	N°	%	N°	%	N°	%	N°	%
Yes	10	12.3	6	7.4	17	21.0	33	40.7
No	11	13.6	10	12.3	27	33.3	48	59.3
Total	21	25.9	16	19.8	44	54.3	81	100.0

(χ^2=0.56, 2 d.f.; P=0.76, minimum expected frequency=6.52)

Table 6.102. Farmer use of advise and farmer formal education

	Use of advise					
	Yes		No		Total	
Formal education	N°	%	N°	%	No	%
Primary Incomplete	3	3.7	9	11.1	12	14.8
P. Complete & Incomplete H.School	3	3.7	7	8.6	10	12.3
Complete High School	10	12.3	9	11.1	19	23.5
Polytech and others	12	14.8	9	11.1	21	25.9
Complete University	5	6.2	14	17.3	48	59.3
Total	33	40.7	48	59.3	81	100.0

(χ^2=6.80, 4 d.f.; P=0.15, minimum expected frequency=4.07)

Table 6.103. Farmer use of agronomic advise and age of the farmer

	Age of the farmer							
	20-39		40-49		+50		Total	
Use of agronomic advise	N°	%	N°	%	N°	%	N°	%
Yes	8	9.9	6	7.4	9	11.1	23	28.4
One of the owners is an agronomist	3	3.7	2	2.5	4	4.9	9	11.1
No	10	12.3	8	9.9	31	38.3	49	60.5
Total	21	25.9	16	19.8	44	54.3	81	100.0

(χ^2=4.10, 4 d.f.; P=0.39, minimum expected frequency=1.78)

Table 6.104. Farmer use of agronomic advise and farmer formal education

	Use of advise							
	Yes		One of the owners is an agronomist		No		Total	
Formal education	N°	%	N°	%	No	%	No	%
Primary Incomplete	2	2.5	0	0.0	10	12.3	12	14.8
P. Complete & Incomplete H.School	2	2.5	0	0.0	8	9.9	10	12.3
Complete High School	5	6.2	0	0.0	14	17.3	19	23.5
Polytech and others	6	7.4	2	2.5	13	16.0	21	25.9
Complete University	8	9.9	7	8.6	4	4.9	19	23.5
Total	23	28.4	9	11.1	49	60.5	81	100.0

(χ^2=25.14, 8 d.f.; P=0.00, minimum expected frequency=1.11)

Table 6.105. Farmer use of veterinary advise and age of the farmer

	Age of the farmer							
	20-39		40-49		+50		Total	
Veterinary visits	N°	%	N°	%	N°	%	N°	%
No visits	1	1.2	1	1.2	4	4.9	6	7.4
1-5	4	4.9	5	6.2	20	24.7	29	35.8
6-10	6	7.4	4	4.9	5	6.2	15	18.5
More than 20	6	7.4	4	4.9	8	9.9	18	22.2
Not very often	4	4.9	2	2.5	7	8.6	13	16.0
Total	21	25.9	16	19.8	44	54.3	81	100.0

(χ^2=7.01, 8 d.f.; P=0.54, minimum expected frequency=1.18)

Table 6.106. Farmer use of veterinary advise and farmer formal education

	Use of advise											
	No visits		1-5		6-10		more than 20		not very often		Total	
Formal education	N°	%	N°	%	No	%					No	%
Primary Incomplete	0	0.0	7	8.6	1	1.2	1	1.2	3	3.7	12	14.8
P. Complete & Incomplete H.School	0	0.0	3	3.7	3	3.7	1	1.2	3	3.7	10	12.3
Complete High School	2	2.5	7	8.6	4	4.9	5	6.2	1	4.9	21	25.9
Polytech and others	3	3.7	8	9.9	3	3.7	3	3.7	4	4.9	21	25.9
Complete University	1	1.2	4	4.9	4	4.9	8	9.9	2	2.5	19	23.5
Total	6	7.4	29	35.8	15	18.5	18	22.2	13	16.0	81	100.0

(χ^2=17.54, 16 d.f.; P=0.35, minimum expected frequency=0.74)

Table 6.107. Farmer perception of competitiveness, new technology and age of the farmer

	Age of the farmer							
	20-39		40-49		+50		Total	
Necessity of new technology	N°	%	N°	%	N°	%	N°	%
Yes	17	21.0	16	19.8	40	49.4	73	90.1
No	4	4.9	0	0.0	4	4.9	8	9.9
Total	21	25.9	16	19.8	44	54.3	81	100.0

(χ^2=3.77, 2 d.f.; P=0.15, minimum expected frequency=1.58)

Table 6.108. Farmer perception of new technology to compite and farmer formal education

	Necessity of new technology					
	Yes		No		Total	
Formal education	N°	%	N°	%	No	%
Primary Incomplete	9	11.1	3	3.7	12	14.8
P. Complete & Incomplete H.School	10	12.3	0	0	10	12.3
Complete High School	18	22.2	1	1.2	19	23.5
Polytech and others	19	23.5	2	2.5	21	25.9
Complete University	17	21.0	2	2.5	19	23.5
Total	73	90.1	8	9.9	81	100.0

(χ^2=4.64, 4 d.f.; P=0.32, minimum expected frequency=0.99)

Table 6.109. Farmers' interest in the latest technology and age of the farmer

	Age of the farmer							
	20-39		40-49		+50		Total	
Interests in the latest technology	N°	%	N°	%	N°	%	N°	%
Yes	7	8.6	8	9.9	13	16.0	28	34.6
No	14	17.3	8	9.9	31	38.3	53	65.4
Total	21	25.9	16	19.8	44	54.3	81	100.0

(χ^2=2.19, 2 d.f.; P=0.33, minimum expected frequency=5.53)

Table 6.110. Farmers' interest in the latest technology and farmer formal education

	Interest in the latest technology					
	Yes		No		Total	
Formal education	N°	%	N°	%	No	%
Primary Incomplete	2	2.5	10	12.3	12	14.8
P. Complete & Incomplete H.School	3	3.7	7	8.6	10	12.3
Complete High School	5	6.2	14	17.3	19	23.5
Polytech and others	8	9.9	13	16.0	21	25.9
Complete University	10	12.3	9	11.1	19	23.5
Total	28	34.6	53	65.4	81	100.0

(χ^2=5.22, 4 d.f.; P=0.26, minimum expected frequency=3.46)

Table 6.111. Farmers that have improved the farm in recent years and age of the farmer

	Age of the farmer							
	20-39		40-49		+50		Total	
Improve the farm in recent years	N°	%	N°	%	N°	%	N°	%
Yes	11	13.6	12	14.8	25	30.9	48	59.3
No	10	12.3	4	4.9	19	23.5	33	40.7
Total	21	25.9	16	19.8	44	54.3	81	100.0

(χ^2=2.16, 2 d.f.; P=0.34, minimum expected frequency=6.52)

Table 6.112. Farmers that have improved the farm in recent years and farmer formal education

	Improve the farm in recent years					
	Yes		No		Total	
Formal education	N°	%	N°	%	No	%
Primary Incomplete	4	4.9	8	9.9	12	14.8
P. Complete & Incomplete H.School	5	6.2	5	6.2	10	12.3
Complete High School	10	12.3	9	11.1	19	23.5
Polytech and others	13	16.0	8	9.9	21	25.9
Complete University	16	19.8	3	3.7	19	23.5
Total	48	59.3	33	40.7	81	100.0

(χ^2=9.00, 4 d.f.; P=0.06, minimum expected frequency=4.07)

Table 6.113. Farmers' that have been working with Plan Agropecuario and age of the farmer

	Age of the farmer							
	20-39		40-49		+50		Total	
Have you been working	N°	%	N°	%	N°	%	N°	%
Yes	5	6.2	7	8.6	15	18.5	27	33.3
No	16	19.8	9	11.1	29	35.8	54	66.7
Total	21	25.9	16	19.8	44	54.3	81	100.0

(χ^2=1.65, 2 d.f.; P=0.44, minimum expected frequency=5.33)

Table 6.114. Farmers that have been working with Plan Agropecuario and farmer formal education

	Use of advise					
	Yes		No		Total	
Formal education	N°	%	N°	%	No	%
Primary Incomplete	1	1.2	11	13.6	12	14.8
P. Complete & Incomplete H.School	2	2.5	8	9.9	10	12.3
Complete High School	3	3.7	16	19.8	19	23.5
Polytech and others	11	13.6	10	12.3	21	25.9
Complete University	10	12.3	9	11.1	19	23.5
Total	27	33.3	54	66.7	81	100.0

(χ^2=13.42, 4 d.f.; P=0.01, minimum expected frequency=3.33)

Table 6.115. Farmers' that had visited a research institution and age of the farmer

	Age of the farmer							
	20-39		40-49		+50		Total	
Had visiting a research institution	N°	%	N°	%	N°	%	N°	%
No	12	14.8	9	11.1	36	44.4	57	70.4
INIA	3	3.7	4	4.9	5	6.2	12	14.8
Others	6	7.4	3	3.7	3	3.7	12	14.8
Total	21	25.9	16	19.8	44	54.3	81	100.0

(χ^2=8.02, 4 d.f.; P=0.09, minimum expected frequency=2.37)

Table 6.116. Farmers' that had visited a research institution and farmer formal education

	Had visiting a research institution							
	No		INIA		Others		Total	
Formal education	N°	%	N°	%	N°	%	No	%
Primary Incomplete	12	14.8	0	0.0	0	0.0	12	14.8
P. Complete & Incomplete H.School	7	8.6	2	2.5	1	1.2	10	12.3
Complete High School	15	18.5	1	1.2	3	3.7	19	23.5
Polytech and others	15	18.5	4	4.9	2	2.5	21	25.9
Complete University	8	9.9	5	6.2	6	7.4	19	23.5
Total	57	70.4	12	14.8	12	14.8	81	100.0

(χ^2=14.88, 8 d.f.; P=0.06, minimum expected frequency=1.48)

Table 6.117. Farmers' objectives today and age of the farmer

	Age of the farmer							
	20-39		40-49		+50		Total	
Objectives	N°	%	N°	%	N°	%	N°	%
To produce more	8	9.9	5	6.2	16	19.8	29	35.8
Schooling for children	6	7.4	3	3.7	8	9.9	17	21.0
Maximise income	3	3.7	5	6.2	2	2.5	10	12.3
Do not have debts	2	2.5	2	2.5	1	1.2	5	6.2
Other	2	2.5	1	1.2	17	21.0	20	24.7
Total	21	25.9	16	19.8	44	54.3	81	100.0

(χ^2=17.90, 8 d.f.; P=0.02, minimum expected frequency=0.99)

Table 6.118. Farmers' objectives three years ago and age of the farmer

	Age of the farmer							
	20-39		40-49		+50		Total	
Objectives	N°	%	N°	%	N°	%	N°	%
To produce more	3	3.7	1	1.2	3	3.7	7	8.6
Maximise income	2	2.5	3	3.7	0	0	5	6.2
Schooling for children	2	2.5	0	0	2	2.5	4	4.9
Other	2	2.5	1	1.2	9	11.1	12	14.8
Do not change	12	14.8	11	13.6	30	37.0	53	65.4
Total	21	25.9	16	19.8	44	54.3	81	100.0

(χ^2=12.38, 8 d.f.; P=0.14, minimum expected frequency=0.79)

Table 6.119. Farmers' important personal achieves and age of the farmer

	Age of the farmer							
	20-39		40-49		+50		Total	
Achieves	N°	%	N°	%	N°	%	N°	%
To be a good farmer	7	8.6	6	7.4	11	13.6	24	29.6
To be a prestigeous farmer	6	7.4	2	2.5	8	9.9	16	19.8
Belong to a farmers' group	1	1.2	2	2.5	12	14.8	15	18.5
Recognition of society to farmers' work	2	2.5	3	3.7	9	11.1	14	17.3
To maintain an active social life	5	6.2	3	3.7	4	4.9	12	14.8
Total	21	25.9	16	19.8	44	54.3	81	100.0

(χ^2=9.63, 8 d.f.; P=0.29, minimum expected frequency=2.37)

Table 6.120. Farmers' main sources of satisfaction and age of the farmer

	Age of the farmer							
	20-39		40-49		+50		Total	
Sources of satisfaction	N°	%	N°	%	N°	%	N°	%
Independence at work	9	11.1	6	7.4	18	22.2	33	40.7
Work with nature	2	2.5	4	4.9	8	9.9	14	17.3
Farming work	4	4.9	5	6.2	3	3.7	12	14.8
Others	6	7.4	1	1.2	15	18.5	22	27.2
Total	21	25.9	16	19.8	44	54.3	81	100.0

(χ^2=9.81, 6 d.f.; P=0.13, minimum expected frequency=2.37)

Table 6.121. Farmers' main reasons to continue farming and age of the farmer

	Age of the farmer							
	20-39		40-49		+50		Total	
Reasons	N°	%	N°	%	N°	%	N°	%
To pass the farm to the next generation	2	2.5	5	6.2	23	28.4	30	37.0
Economic reasons	15	18.5	4	4.9	7	8.6	26	32.1
Give education for children	2	2.5	1	1.2	2	2.5	5	6.2
Continue working	0	0.0	3	3.7	2	2.5	5	6.2
Other	2	2.5	3	3.7	10	12.3	15	18.5
Total	21	25.9	16	19.8	44	54.3	81	100.0

(χ^2=28.65, 8 d.f.; P=0.00, minimum expected frequency=0.99)

Table 6.122. Farmers' satisfaction with their work and age of the farmer

	Age of the farmer							
	20-39		40-49		+50		Total	
Are you happy to be a farmer ?	N°	%	N°	%	N°	%	N°	%
Yes	19	23.5	12	14.8	41	50.6	72	88.9
No	2	2.5	4	4.9	3	3.7	9	11.1
Total	21	25.9	16	19.8	44	54.3	81	100.0

(χ^2=4.00, 2 d.f.; P=0.14 minimum expected frequency=1.78)

Table 6.123. Farmers' satisfaction with their work and farmer formal education

	Are you happy to be a farmer ?					
	Yes		No		Total	
Formal education	N°	%	N°	%	No	%
Primary Incomplete	11	13.6	1	1.2	12	14.8
P. Complete & Incomplete H.School	8	9.9	2	2.5	10	12.3
Complete High School	17	21.0	2	2.5	19	23.5
Polytech and others	18	22.2	3	3.7	21	25.9
Complete University	18	22.2	1	1.2	19	23.5
Total	72	88.9	9	11.1	81	100.0

(χ^2=1.77, d.f.; P=0.78, minimum expected frequency=1.11)

Table 6.124. Farmers' farm income perception and age of the farmer

	Age of the farmer							
	20-39		40-49		+50		Total	
The farm income is :	N°	%	N°	%	N°	%	N°	%
Good	2	2.5	1	1.2	2	2.5	5	6.2
Acceptable	12	14.8	7	8.6	22	27.2	41	50.6
Bad	7	8.6	8	9.9	20	24.7	35	43.2
Total	21	25.9	16	19.8	44	54.3	81	100.0

(χ^2=1.60, 4 d.f., P=0.81, minimum expected frequency=0.99)

Table 6.125.Farmers' farm income perception and farmer formal education

	The farm income is :							
	Good		Acceptable		Bad		Total	
Formal education	N°	%	N°	%	N°	%	No	%
Primary Incomplete	1	1.2	7	8.6	4	4.9	12	14.8
P. Complete & Incomplete H.School	2	2.5	6	7.4	2	2.5	10	12.3
Complete High School	1	1.2	9	11.1	9	11.1	19	23.5
Polytech and others	1	1.2	9	11.1	11	13.6	21	25.9
Complete University	0	0.0	10	12.3	9	11.1	19	23.5
Total	5	6.2	41	50.6	35	43.2	81.0	100.0

(χ^2=7.15, 8 d.f.; P=0.52, minimum expected frequency=0.62)

Appendix 6.D. Thesis Questionnaire

Encuesta para Ganaderia Extensiva sobre Basalto

El INIA se encuentra estudiando cuales son los principales factores que inciden en el proceso de toma de decisiones por parte del productor ganadero, a efectos de establecer como apoyar mas eficientemente al productor. de decisiones.

La informacion aqui presentada es totalmente confidencial, teniendo como unico objetivo el poder caracterizar y definir mas adecuadamente el proceso de toma de decisiones por parte de los productores ganaderos sobre basalto.

Finalmente se desea agradecer por la colaboracion brindada al responder a las preguntas detalladas en este formulario.

1.Fecha de la Entrevista

2. Nombre del Encuestador

3. Numero de Registro: Numero formulario encuesta equipos.

I. Informacion General

4. Numero de DICOSE: __/__/_____

5. Lugar o paraje ______________________

6. Direccion de la entrevista ______________________

7.Nombre y cargo del entrevistado:

1.Titular y administrador
2. Administrador
3. Mayordomo
4. Otro

1

8. Cuanto tiempo hace que es productor ?

2

9. Cuanto tiempo hace que trabaja en este predio ?

3

10. Como obtuvo el predio?
1. Compra
2. Tenencia(arrendamiento u otras)
3. Tenencia y compra
4. Couta parte en sociedad familiar
5. Sociedad no familiar
6.Sociedad con el dueno de la tierra
7.Transferencia de prop. de la familia
8.Herencia o Sucesion
9.Administrador
10. Propiedad del conyugue
11.Otras

4 5

11. Administra usted directamente el predio ? Si No

6

12. Si usted no lo hace, quien se encarga de hacerlo?

1. Mayordomo
2. Administrador Tecnico
3. Administrador no tecnico
4. Socio
5. Capataz

7

13. Entre que rango de edades se ubica ud.?

1. menos de 25
2. 25 - 39
3. 40 - 59
4. Mas de 60

8

14. Razon Social

1	2	3
Persona fisica	Sociedad	Otros

9

15. Tenencia.

	Area	Unidad	
1. Propietario			10 11
2.Arrendatario			12 13
3.Medianero			14 15
4.Otros			16 17
5. Total			18 19

16. Actividad Principal
1.Vacunos
2.Lanares
3.Lecheria
4. Otros

20

17. Giro principal en vacunos

Cria	Ciclo Completo	Engorde	Cabania

21

18. Giro principal en Lanares.

Cria	Ciclo Completo	Cabania

22

19. Total cabezas de ganado vacuno ____________ 23

20. Total cabezas de ganado ovino ____________ 24

21. Total Yeguarizos ____________ 25

22. Participa Ud. de las decisiones del establecimiento?

Si	No

26

23. La decision de dedicarse a ....es debida a la decision de:

	Peso relativo en %		
1 Padre			27
2 Productor			28
3 Conyugue			29
4 Hijo 1			30
5 Hijo 2			31
6 Socio/s			32
7 Parientes			33
8 Asesores			34
9 Vecinos			35
10 Otros(esp.)			36
11 Otros(esp.)			37

24. Cual es la principal razon por la cual se dedica a ....(ingresar datos respuesta anterior)
Si marca mas de una indicar prioridad

	Si	No			
1.Tierra disponible			38	39	40
2. Capital disponible			39	42	43
3. Rentabilidad			44	45	46
4. Aptitud de los Suelos			47	48	49
5. Mercados			50	51	52
6. Tradicion			53	54	55
7. Conocimientos			56	57	58
8. Estilo de vida			59	60	61
9. Herencia			62	63	64
10. Expectativas de futuro			65	66	67
11. Vocacion			68	69	70
12. Edad			71	72	73
13. Otros			74	75	76

25. Esta Ud. pensando en cambiar el giro o actividad del establecimiento?

	Si	No	Quizas	
1. Vacunos				77
2. Lanares				78
3. A cual:				79

26. (si 24 es si o quizas) Porque no lo ha hecho hasta ahora ?

1 ______ 80

9 no corresponde ______ 81

27. Ud preferiria :

1. Trabajar solo con vacunos
2. Trabajar solo con lanares
3. Trabajar vacunos y lanares conjuntamente

82

28. Priorice porque razones trabaja lanares y vacunos conjuntamente?
(indicar las tres principales causas priorizadas)

1. Mejora las posibilidades de manejo
2. Diversifica los ingresos
3. Disminuye el riesgo de produccion
4. Disminuye el riesgo economico
5. Se logra un mejor ajuste de carga
6. Complementan el uso de los recursos
7. Otras

83 84
85 86
87 88

29. Dadas las actuales condiciones de precios de la lana esta ud. pensando en:
(no mas de dos y priorizadas)

1. Reducir el numero de ovinos
2. Reorientar la produccion hacia la carne
3. Reorientar la produccion hacia la leche ovina
4. Reorientar la produccion para producir lana mas fina
5. Dejar unos pocos ovinos para consumo
6. Mejorar la calidad de la majada
7. Eliminar los ovinos
8. Aumentar el numero de ovinos

89 90
91 92

30. Ha solicitado usted algun tipo de asesoramiento que lo impulsara a cambiar las actividades prediales?

Si No 93

31. Ha realizado usted algun tipo de estudio o analisis antes de decidirse a cambiar las actividades prediales?

Si No 94

32.(si piensa cambiar) Cuales son los principales motivos que lo impulsan a cambiar ?
(priorice)

1. Falta de rentabilidad
2. Trabajo frecuentemente muy duro
3. Alta presion impositiva
4. Competencia con otras actividades
5. Para tener mas tiempo con la familia
6. Para ir hacia una actividad mas empresarial
7. Presiones familiares
8. Presiones por deudas
9. Falta de satisfacion con la actividad
10. Inversiones en actividades extraprediales
11. Diversificar los ingresos
12. No corresponde

95 96 97

98 99 100

101 102 103

33. Piensa ud. diversificar las actividades del predio?

Si No

104

34. (si va a diversificar) Que actividad o actividades piensa encarar?

105

35. Piensa Ud. dejar la actividad en el corto plazo (5 anios)agropecuaria ?

Si No Quizas

106

36.(Si piensa dejar la actividad) A cual?

107

37. Quienes son las personas influyentes en las decisiones predio(inversiones, praderas
(maximo tres) cambio de vehiculo, etc)

Peso relativo en %

1 Padre
2 Productor
3 conyugue
4 Hijo 1
5 Hijo 2
6 Hijo 3
7 Parientes
8 Asesores
9 Vecinos
10 Socios
11 Otros

108 109 110

111 112 113

114 115 116

38. Hay que seguir trabajando en el predio para:?
(en el caso de mas de una razon indique el orden de prioridad)

1. Pasar el predio a la proxima generacion
2. Obtener el maximo ingreso posible
3. Tener un vehiculo cero kilometro
4. Maximizar el tiempo fuera del predio
5. Maximizar el estandar de vida
6. Minimizar el pago e impuestos
7. Dar educacion a los hijos
8. No desaparecer como productor
9.Mejorar la calidad de la tierra
11.Incrementar el beneficio neto(no maximizar)
12. Obtener productos de la mejor calidad
13. Tener independencia financiera
14. Aumentar el tamanio del predio
15. Sobrevivir
16. Porque es lo que mejor se hacer
17.Otros

117 118 119
120 121 122
123 124 125

39. Esta Ud. conforme con ser productor rural?

Si No

126

40. (si esta confrome) Porque?

1

127

9 No corresponde

128

41. (si 27 es no)Porque?

1

129

9 No corresponde

130

42. Considera Ud. que el ingreso que obtiene en el predio es :

1. Muy bueno
2. Bueno
3. Aceptable
4. Malo

131

43. Que le gustaria pasarle a sus hijos:
(si responde mas de una priorizar)

1. Conocimientos para que sean buenos productores
2. Una profesion liberal
3. Mas campo
4. Dinero
5. El campo poblado y en plena produccion
6. Una casa en la ciudad
7. Un trabajo en la ciudad
8. Otros
9. No corresponde

132 133

134 135

136 137

44. Ud. es un productor que busca incorporar los ultimos adelantos tecnologicos o prefiere esperar el resultado de las nuevas tecnologias en otros productores?

Si	No	
		138

45. Uso de la tierra

	Hectareas	%			
1. Pasturas Naturales				139	140
2. Pasturas naturales fert.				141	142
3. Siembra en cobertura				143	144
4. Zapata				145	146
5. Pasturas convencionales				147	148
6. Cultivo 1				149	150
7. Cultivo 2				151	152
8. Cultivo 3				153	154
9. Verdeos de invierno				155	156
10. Montes artificiales				157	158
11. Montes naturales				159	160
12. Rastrojos				161	162
13. Area no productiva				163	164
Total				165	166

46. Donde viven generalmente usted y su familia ?

	Productor	Familia
1. En el predio		
2. En el predio y una ciudad cerca del predio		
3. En el predio y un ciudad lejos del predio		
4. Fuera del predio		

167 168

47.(Si vive fuere del predio) Con que frecuencia va a el establecimeinto?

1 Todos los dias
2 Una a tres veces por semana
3 Una a tres veces por mes
4 Una a tres veces por semestre
5 No corresponde

169

48.cual es el principal medio que utiliza para comunicarse?

	siempre	principalmente	a veces	nunca
1. Correo				
2. Telefono				
3. Fax				
4. Radio				
5. Radiotelefonogramas				

170 171

49. (Si reside en el predio) Cuan frecuentemente va a la ciudad?

1 Todos los dias
2 Una a tres veces por semana
3 Una a tres veces por mes
4 Una a tres veces por semestre
5 No corresponde

172

50. Considera ud. que no residir en el predio afecta negativamente el manejo del mismo?

SI NO

173

51.(Si respondio que si) De que forma?

____

174

52. Composicion del nucleo familiar y educacion Formal

	Est. Civil (cas/sol/viudo)	Edad	Ultimo anio cursado	Vive en el predio
1.Productor	175	176	177	178
2. conyugue	179	180	181	182
3. Hijo 1	183	184	185	186
4. Hijo 2	187	188	189	190
5. Hijo 3	191	192	193	194
6. Otros(esp.)	195	196	197	198
7. Otros(esp.)	199	200	201	202
Otros(esp.)	203	204	205	206

1. Casado	1. 1-9	1. Primaria Incompleta	1. Si
2. Soltero	2. 10-19	2. Primaria Completa	2. No
3. Divorciado	3. 20-29	3. Secundaria Incompleta	
4. Separado	4. 30-39	4. Secundaria Completa	
5. Concubino	5. 40-49	5. Universidad Incompleta	
6. Viudo	6. 50-60	6.Universidad Completa	
	7. + 60	7. Ensenianza Tecnica	
		8. Otros	
		9. Sin Instruccion	

53. Educacion no formal

	1 Todos los anios	2 Cada 2 o 3 anios	3 Casi Nunca	4 Nunca		
1. Cursos cortos						206
2. Dias de campo						207
3. Seminarios						208
4. Congresos						209
5. Charlas Tecnicas(exp.)						210
6. Capacitacion en Administracion						211
7. Capacitacion en computacion						212

54. Dispone Ud de alguna habilidad especial como:

1.Mecanico
2.Tractorista
3. Inseminador
4. Alambrador
5. Esquilador
6. Domador
7. Contabilidad
8. Usuario PC
9. No tiene

213 214

55. Ademas de Productor o Administrador dispone Ud de otra actividad

Si   No   215

56.(si tiene) Cual?

1.Empleo Privado
2. Empleo Publico
3. Profesional
4. Comerciante
5. Industrial
6. Rematador/Escritorio Rural
7. Veterinaria/venta insumos agrop.
8. Otro
9. No corresponde

216 217

57.Esta Ud de acuerdo con las siguientes afirmaciones:

1. Trabajar fuera del predio es imprescindible para afrontar los gastos
2. Es bueno tener una diversificacion de los ingresos
3. La actividad que realiza fuera del predio es la que realmente le gusta
4. Es dificil pero aun se puede vivir del campo
5. Me gustaria solamente trabajar en mi campo pero no puedo
6. Los trabajos son complementarias y gano experiencia para los dos
7. Es mejor invertir las ganacias del predio fuera de el   218 219
8. Otra

220 221

58. Podria usted ingresar la informacion en el cuadro correspondiente:

Relacion	Actividades en el predio: % trabajo en el predio	% trabajo fuera predio	% ingreso en el predio	% ingreso fuera predio
1. Productor	222	223	224	225
2. Conyugue	226	227	228	229
3. Hijo 1	230	231	232	233
4. Hijo 2	234	235	236	237
5. Hijo 3	238	239	240	241
6. Otros(esp.)	242	243	244	245
7. Otros(esp.)	246	247	248	249
8. Otros(esp.)	250	251	252	253

59. Lleva usted algun tipo de registro?
(si mas de uno priorice)

1.Datos de Clima
2.Gastos e ingresos
3.Financieros
4.Pastoreo
5.Produccion
6.Geneticos
7.Carpeta Verde
8.Carpeta DIEA
9.SUL(flock testing)
10.ARU(Pedigree)
11.FUCREA
12.DICOSE
13.Otros
14.Ninguno

254 255 256
257 258 259
260 261 262

60. Donde busca informacion para basar su toma de decisiones?
(indique orden de prioridad de uno a cuatro)

1.Escritorio Rural
2. Vecinos
3. Consignatario
4. Abogado
5. Contador
6. Ing.Agronomo
7. Veterinario
8. Medico
9. Registros
10. Familia
11. Pariente
12. Radios
13.Diarios
14.Television
15. Revistas Tecnicas
16. INIA
17. Universidad
18. SUL
19. Plan
20. Exposiciones
21. Asoc.Rural
22. Fed.Rural
23. Cooperativa
24. Soc.Fomento
25. Grupos de productores
26. Int. Municipal
27. Otros

263 264 265
266 267 268
269 270 271
272 273 274

61. En que se basa para elegir su principal proveedor de insumos?
(si mas de uno priorice)

1. Financiamiento de productos
2. Mejores precios
3. Stock de insumos
4. Calidad de los productos
5. Confianza en la firma
6. Apoyo tecnico
7. Trato de los empleados
8. Entrega inmediata de los productos
9. Amistad o relacionamiento
10. Otros

275 276 277
278 279 280
281 282 283

62. Cada vez que va a hacer una compra importante de insumos:

1. Averigua precios en comercios locales
2. En comercios locales y Montevideo
3. Generalmente compra en el mismo lugar
4. Consulta con los vecinos
5. Consulta con los parientes
6. Consulta en la Cooperativa
7. Consulta en el Escritorio Rural
8. Consulta con su asesor
9. Consulta revistas especializadas
10. Otros

284 285 286
287 288 289
290 291 292

63. Quien es el encargado de llevar los libros o registros?

	nunca	casi nunca	a veces	siempre		
1. Productor						293
2. Conyugue						294
3. Socio						295
4. Hijo						296
5. Contador						297
6. Gestoria						298
7. Asesor Agrop.						299
8. Empleados						300
9. Otros						301

64. Tiene Ud computadora?

Si No

302

65..(Si no tiene) Porque?

66. (Si tiene) La usa como apoyo en el manejo del predio ?

Si No

303

67. Usa ud informacion procesada en computadoras como apoyo al manejo del predio:
(si mas de uno priorice)

1. De la Cooperativa
2. Del asesor Agropecuario
3. Del Gestor
4. Del contador
5. FUCREA
6. SERAGRO
7. Plan Agropecuario
8. SUL
9. Otros
10. No corresponde

304 305 306
307 308 309

68(Si el computador es propio)Cual es su principal uso?

1. Programas especiales
2. Analisis financieros(Hoja electronica)
3. Contabilidad
4. Procesador de textos
5. Registros financieros
6. Registros de produccion
7. Programa carpetas de FUCREA
8. Carpeta Verde en Lotus
9. Educacion y juegos para los hijos
10. Llevar DICOSE
11. Otros

310 311 312
313 314 315
316 317 318

69.(Si lleva registros) Porque lleva registros?
(Economico Financieros)

1.Porque los necesito para manejar el predio
2.Porque me lo exigen (Socios, bancos, DICOSE, etc)
3.Porque el asesor los necesita
4.Para tener lo papeles ordenados
5.Para poder gestionar creditos ante los bancos
6.Otros
9. No corresponde

319 320

70.(Si lleva registros) Para que utiliza la informacion que registra?

1.Conocer la situacion del predio
2.Para tomar decisiones de inversion
3.Para planificar las actividades del predio
4.Para tomar decisiones productivas
5.Para tener una contabilidad prolija
6.Para saber los costos de produccion
7.Otros
8.No la usa
9.No corresponde

321 322
323 324
325 326

71. Sabe Ud. cual es su costo de produccion?

Si No

327

Si es si cuanto es por Ha U$ $

328 329

72. Para tener exito en el manejo del predio hay que tomar decisiones basado en :
(Ordenelos de acuerdo a la prioridad que Ud. asigne)

1. Informacion interna del predio
2. Informacion de mercados
3. Informacion de los asesores
4. Informacion de precios de insumos
5. Informacion del predio y de mercados
6. Otros

330 331
332 333
334 335

73. En que tipo de informacion se basa mas en su toma de decisiones:

1. Totalmente Formal
2. Principalmente formal
3. Formal e informal
4. Principalmente informal
5. Totalmente informal

336

74. El apoyarse en uno u otro tipo de informacion varia con el tipo de decision?

Si	No	No sabe

337

75. (Si la respuesta es si),En que tipos usa formal y en cual informal?

No corresponde

338

76. De acuerdo a su experiencia, para tomar buenas decisiones hay que basarse en :?

1.Solo intuicion
2.Principlamente intuicion
3. Intuicion y analisis
4. Principalmente analisis
5. Solo analisis

339

77. Que decisiones entre las siguientes son las que a su juicio requieren mayor analisis?

Las vinculadas a:

1. Inversiones
2. Creditos
3. Compra de ganado
4. Venta de ganado
5. Plan sanitario
6. Plan de alimentacion
7. Compra de insumos
8. Cambios de rubros

340 341
342 343
344 345
346 347

78. Para cuales de las siguientes decisiones piensa ud. que es necesario disponer de apoyo ?
Respuesta en orden de importancia

1.Decisiones productivas
2.Decisiones financieras
3.Decisiones economicas
4.Decisiones tecnologicas
5.Decisiones de cambio de actividad

348 349
350 351

79. Piensa ud. que el productor debe concentrar mas sus esfuerzos en :
Respuesta en orden de importancia

1.Decisiones productivas
2.Decisiones financieras
3.Decisiones economicas
4.Decisiones tecnologicas
5.Decisiones de cambio de actividad

352 353
354 355

80. Quien toma generalmente las siguientes decisiones?

	manejo Anim/Pastura	compras animales	ventas animales	Inversiones
1. Productor	356	357	358	359
2. Conyugue	360	361	362	363
3. Socio	364	365	366	367
4. Hijo	368	369	370	371
5. Administrador	372	373	374	375
6.Padre	376	377	378	379
7. Asesor Agrop.	380	381	382	383
8. Capataz	384	385	386	387
9. Peones	388	389	390	391
10. Otros	392	393	394	395

81. Las decisiones economico financieras de todos los dias son principalmente hechas por:
(pago de impuestos, pago de salarios, pago de insumos, bancos, etc)

1. Productor
2. Conyugue
3. Socio
4. Hijo
5. Administrador
6. Gestoria
7. Asesor Agrop.
8. Capataz
9. Padre
10. Otros

396 397

398 399

82. Toma Ud. ideas de otros productores?

Si No

400

83. Toman otros productores ideas suyas?

Si No

401

84. Cual de las siguientes actividades le ha resultado provechosa para el manejo de su predio? (si marca mas de una priorice de 1 a 3)

1. Jornadas tecnicas
2. Dias de campo
3. Seminarios
4. Reuniones en campos de productores
5. Reuniones en estaciones experimentales
6. Intercambio de ideas con otros productores
7. Intercambio de ideas con tecnicos
8. Intercambio de ideas en escritorios locales
9. Intercambio de ideas en la cooperativa
10. Otros

402 403 404
405 406 407
408 409 410

85. Piensa Ud. que incorporar mejoras tecnologicas produce ventajas economicas en el predio?

Si	No	Depende

411

86. Ha incorporado alguna mejora en los ultimos anios?

Si	No

412

87. Porque?

88. Piensa Ud. que con el ingreso del pais al MERCOSUR la situacion de la ganaderia tendra algun cambio?

Si	No	No sabe

413

89. Piensa Ud que para poder competir hay que tecnificarse?

Si	No	No sabe

414

90. A su jucio cual es el principal problema a solucionar en el campo?

____

415

91. Que tipo de organizacion tiene su establecimeinto?

1. Familiar
2. Principalmente familiar
3. Empresa familiar
4. Principalmente empresarial
5. Empresarial

416

92. Que tipo de organizacion piensa Ud. es la que permite trabajar mejor?

1. Familiar
2. Principalmente familiar
3. Empresa familiar
4. Principalmente empresarial
5. Empresarial

417

93. Cree Ud. que la organizacion del trabajo en el predio es un aspecto:

1. Importante
2. Hay que considerarlo
3. Poco importante
4. No es importante

418

94. Programa Ud. las actividades del predio con algunos meses de antelacion o va tomando las decisiones segun se desarrollan los acontecimientos ?

Siempre	Casi Siempre	Raras veces	nunca

419

95. (Si programa) La programacion que hace es generalmente:

1. Trimestral
2. Semestral
3. Anual
4. Bianual
5. Quinquenal

420

96. (si programa)Cuales de las siguientes son mas importantes de programar:
(priorice de 1 a 3)

1. Inversiones
2. Sanidad
3. Alimentacion
4. Creditos
5. Ventas
6. Compras de insumos
7. Pago de Impuestos
8. Compra de animales
9. Cambio de actividad

421 422
423 424
425 426

97. Piensa Ud. que el productor agropecuario esta preparandose para las nuevas condiciones de produccion?

Si	No	Algunos si

427

98. La mano de obra disponible para las actividades rurales es:

	no capacitada	poco cap.	Bien capacitada	
1. Muy escasa				428 429
2. Escasa				430 431
3. Adecuada				432 433
4. Excesiva				434 435

99. Piensa ud. que la mano de obra es restrictiva para la incorporacion de nuevas tecnologias?

1 Si
2 No
3 No sabe

436

100.(Si respondio que si a la anterior) Porque?

437

101. Cuanta mano de obra no-familiar permanente emplea ud. en promedio por anio?

Numero:

438

102. Cuanta mano de obra no-familiar zafralmente emplea en el predio?

Numero:

439

103. Cuales serian las edades del personal que trabaja en el,predio?

Numero:

15-20	20-30	30-40	40-50	mas de 50
440	441	442	443	444

104. El ingreso del predio comparado con otros anios es:

mucho mas bajo	mas bajo	igual	mejor	mucho mejor	
					445

105. Si hubo cambio a que lo atribuye?

446

II. Objetivos

A continuacion se describiran algunos de los objetivos que algunos productores han indicado como import antes, indique a su criterio cuale serian importantes:

	Muy importante	Bastante importante	importante	no muy importante	no sabe	
106. Participar en exposiciones ganaderas						447
107. Tener equipo y maquinaria nueva y moderna						448
108.Tener pasturas mejoradas						449
109.Mantener los edificios e instalaciones en buenas condiciones						450
110. No tener deudas						451
111.Saber cuando retirarse y dejar paso a las nuevas generaciones						452
112. Realizar una adecuada planificacion						453
113.Invertir las ganancias principalmente en el predio.						454
114. Invertir principalmente fuera del predio para diversificar los ingresos						455
115. Invertir en un vehiculo cero kilometro						456
116. Invertir en forestacion para abrigo y sombra de los animales						457
117. Lograr un buen estandar de vida para la familia						458
118. Contar con una casa confortable en el predio.						459
120.Tener electricidad(generador)						460
121.Tener agua de buena calidad en todos los potreros						461

	Muy importante	Bastante importante	importante	no muy importante	no sabe	
122.Realizar un buen control sanitario.						462
123.Mantener los animales en buenas condiciones nutritivas.						463
124.Hacer cruzamientos						464
125.Comprar animales para ajustar la carga.						465
126.Saber a que edad comprar los animales.						466
127.Saber conque peso comprar los animales para engorde						467
128.Comprar ganado de clase y buena raza.						468
129.Comprar ganado para engordar.						469
130.Dar prioridad en el pastoreo a las categorias jovenes						470
131.Destetar temprano(otonio)						471
132.Lograr vender mucho ganado gordo						472
133. Tener buenos terneros para venderselos a los invernadores.						473
134.Tener bastantes potreros.						474
135.Comprar toros de buena calidad.						475
136.Fijar adecuadamente la epoca de entore.						476
137.Entorar las vaquillonas a los 2 anios o antes						477

	Muy importante	Bastante importante	importante	no muy importante	no sabe	
138. Lograr buenos porcentajes de marcacion						478
139. Lograr buenos pesos de destete						479
140.Poder vender ganado gordo en postzafra						480
141. Engordar las vacas falladas y de refugo.						481
142.Realizar diagnostico de gestacion						482
143. Castrar las vacas falladas						483
144. Suministrar sales minerales al ganado todo el anio						484
145.Darle suplemento en el invierno.						485
146.Lograr buena calidad en los productos del predio						486
147. Poder comprar mas campo.						487
148.Poder destinarle tiempo a la familia.						488
149. Darle una buena educacion a los hijos.						489
150.Poder tomarse unas vacaciones fuera del predio						490
151. Es importante ayudar a los vecinos.						491
152.Es importante trabajar duro para mejorar.						492
153.Ir logrando objetivos paso a paso.						493

	Muy importante	Bastante importante	importante	no muy importante	no sabe
154. Tener fijados objetivos productivos de largo plazo					
155. Trabajar en grupos es mejor que trabajar solo					
156. Mantenerse al dia con los nuevos adelantos tecnologicos					
157. Se hace mas dinero especulando que produciendo					

494
495
496
497

158.Cual de las siguientes objetivos se ajustan mas a su situacion hoy:
(priorice hasta tres

1. Ser el mejor productor de la zona
2. Reducir la carga de trabajo y mejorar la calidad de vida
3. Producir mas
4. Maximizar los ingresos
5. Aumenar el tamanio del predio, comprar mas tierra
6. Diversificar produccion e ingresos invirtiendo dentro y fuera del predio
7. Dar educacion a sus hijos
8. Poder dar trabajo a toda la familia
9. Producir conservando los recursos
10. No tener deudas (sanear la empresa de deudas)
11. Invertir en mejoras e infraestructura
12. Tener montes de abrigo y sombra para los animales
13. Poder contar con dinero suficiente para las vacaciones
14. Otros ______

498 499 500
501 502 503
504 505 506

159. Hace tres anios se planteaba los mismos objetivos ?

1. Ser el mejor productor de la zona
2. Reducir la carga de trabajo y mejorar la calidad de vida
3. Producir mas
4. Maximizar los ingresos
5. Aumenar el tamanio del predio, comprar mas tierra
6. Diversificar produccion e ingresos invirtiendo dentro y fuera del predio
7. Dar educacion a sus hijos
8. Poder dar trabajo a toda la familia
9. Producir conservando los recursos
10. No tener deudas (sanear la empresa de deudas)
11. Invertir en mejoras e infraestructura
12. Tener montes de abrigo y sombra para los animales
13. Poder contar con dinero suficiente para las vacaciones
14. Otros

507 508 509

510 511 512

513 514 515

160. En el caso que sean diferentes, cuales fueron las principales razones que lo motivaron?

1. Razones familiares
2. Deudas
3. Falta de estimulos economicos
4. Falta de estimulos personales
5. Buenas ganancias
6. Obtencion de un credito
7. Motivacion personal
8. Otros especificar
9. No corresponde

516 517

518 519

161. Es importante para ud.:

1. Ser un productor de prestigio
2. Pertenecer a una sociedad de criadores
3. Tener reconocimineto de la sociedad por el trabajo que esta haciendo
4. Mantener un activa vida social(reuniones, etc)
5. Pertencer a un grupo CREA
6. Pertenecer a una Cooperativa o soc. de fomento rural
7. Otros

520 521

522 523

524 525

162.Cuales son las principales fuentes de satisfaccion que tiene en su trabajo?

1. Independencia en el trabajo
2. Trabajar en contacto con la naturaleza
3. El trabajo en si mismo
4. Poder vivir con poco dinero
5. Oportunidad de ganar dinero
6. Continuar con la tradicion familiar
7. Poder intercambiar ideas con otros productores
8. Poder trabajar cerca de mi familia
9. La falta de rutina en el trabajo
10. Tener tiempo libre para trabajar en otras actividades

526 527

528 529

530 531

III. Decisiones de Produccion

III.1. Manejo de pasturas

163. Cual es su principal objetivo en relacion con las pasturas ?

1. Mejorar el suelo
2. Alimentacion para el ganado
3. Evitar que se endurezcan
4. Mejorar la calidad
5. Mejorar la cantidad
6. Controlar la erosion
7. Mantener el campo natural
8. Tener las mejores pasturas
9. Otra

532 533

534 535

164. Que criterio utiliza para tomar decisiones de manejo con las pasturas?
Si utiliza mas de una ingresar importancia relativa.

1. Cantidad de leguminosas
2. Cantidad de Raigras
3. Cantidad y tipo de malezas
4. Cantidad de pasto miel
5. Cantidad de espartillo
6. Habito de pastoreo de los animales
7. Ganancias de peso de los animales
8. Grado de madurez de las pasturas
9. Color de la pastura
10. Topografia
11. Disponibilidad de forraje
12. Relacion verde/seco

536 537 538

539 540 541

542 543 544

165. De acuerdo a su experiencia, cual es el periodo mas critico para los animales y pasturas?

1. Verano
2. Otono
3. Invierno
4. Primavera
5. No sabe

545 546

166. Ha tomado usted alguna medida para atenuar esa falta de alimento ?

1. Heno o fardos
2. Suplementos alimenticios
3. Praderas convencionales
4. Siembra en cobertura
5. Siembra a zapatas
6. Verdeos anuales
7. Complemento con Racion
8. Vender animales
9. Sacar a pastoreo
10. No

547 548 549

550 551 552

553 554 555

167. La carga animal con la que trabaja durante el anio esta acorde a la oferta de forraje? (de otra forma, le falta o le sobra forraje en el anio)

Si no

556

168. Conque carga promedio trabaja?

1. O.4 animales /ha
2. O.6 animales/ha
3. O.8 animales/ha
4. 1.O animales/ha
5. 1.2 animales/ha
6. mas de 1.2
7. No sabe

557

169. Ha realizado ud algun tipo de mejoramiento de campo?

Si no

558

170. Que especies utilizo?

559

171. (Si hace)Que tipo de manejo se ajusta mas al que ud. realiza con sus mejoramientos:

1. Refertiliza anualmente
2. Cada dos anios
3. Otra
4. Nunca
5. No corresponde

560

172. (Si hace) Para manejar sus mejoramientos ud. considera:

1. Alivio de la carga animal
2. Cierre del portero
3. Arrase de fin de verano
4. Pastoreo continuo todo el anio

561

173. Como asigna las pasturas de acuerdo con la categoria animal?

Preguntar por categoria- ej Los terneros pasan todo el anio en campo natural?

	Verano	Otonio	Invierno	Primavera
Ternero	562	563	564	565
Ternera	566	567	568	569
Novillo de 1 anio	570	571	572	573
Novillo de 2 anios	574	575	576	577
Novillo de 3 anios	578	579	580	581
Novillo de 4 anios	582	583	584	585
Vaquillona de 1 anio	586	587	588	589
Vaquillona de 2 anios	590	591	592	593
Vaca de cria	594	595	596	597
Vaca de invernada	598	599	600	601

Pregunta defecto, Estan siempre en ......

	codigo
Pasturas Naturales	1
Pasturas Naturales Fertilizadas	2
Siembra en cobertura	3
Zapata	4
Pasturas Convencionales	5
Verdeos anuales	6
Otros especificar	7

174. Piensa ud. incorporar en el futuro alguna practica para mejorar la alimentacion del ganado ?

Si	No	No sabe

602

175. (Si responde que si) Cuales?

603

176. Como determina la condicion de la pastura o potrero?

1 Altura
2 Area cubierta por malezas
3 Cantidad de panojas
4 Color de la pastura
5 Cantidad de forraje verde
6 Relacion verde/seco
8 Otros ______

604 605
606 607

177. Piensa Ud que se deben destinar las mejores pasturas al engorde ?

Si No

608

178. Explique porque?

1.Porque es mas rentable
2. Porque se maneja mejor
3. Para lograr terminar en post-zafra
4. Porque la actividad principal es engorde
5. Porque deteriora menos las pasturas
9. No corresponde

609

179. Si en este momento contara con dinero, que inversion o mejora haria ? ______

610

II.1. Manejo de los animales

180. Realiza Ud algun tipo de suplementacion o complementacion por categoria ?

Si	No	
		611

181 a. (Si realiza a que categorias) Incluye el pastoreo

	Verano	Otonio	Invierno	Primavera
1.Ternero	612	613	614	615
2.Ternera	616	617	618	619
3.Novillo de 1 anio	620	621	622	623
4.Novillo de 2 anios	624	625	626	627
5. Novillo de 3 anios	628	629	630	631
6.Novillo de 4 anios	632	633	634	635
7.Vaquillona de 1 anio	636	637	638	639
8. Vaquillona de 2 anios	640	641	642	643
9. Vaca de cria	644	645	646	647
10.Vaca de invernada	648	649	650	651

Heno	1
Pastoreo Diferido	2
Racion	3
Sales Minerales	4
Pastoreo fuera del predio	5
Otro	6

181 b. Basa ud. el manejo de los animales en la condicion de los animales?

Si	No	
		652

182. Que criterio utiliza para determinar la condicion de los mismos.?

1 apreciacion visual
2 Balanza
3 Cantidad de grasa en el espinazo
4 Cantidad de grasa en el lomo
5 Color del pelo
6 Otros

653

183. Compra Ud. animales para invernar?

Si No A veces

654

184. Cuales son las principales razones para comprar animales ?

655

185. Que informacion utiliza para comprarlos?

656

186. Piensa Ud que es mejor comprar categorias jovenes ?

SI No

657

187. Cuales son las principales razones para fundamentar su respuesta anterior?

658

188. A su criterio cuales son las decisiones mas importantes a tomar en el anio?

659

189. De estas cual es la que para Ud le resulta mas compleja?

660

190. Porque?

661

CODIGOS AUXILIARES

662	663
664	665
666	667
668	669
670	671
3 672	673

Appendix 6.E. Equipos Questionnaire

Farmer Data

1. Name:

2. Address of the interview:

3. Are you the owner or the manager of the farm ?

Owner and manager

Manager

Other

4. Age

1. less than 25
2. 25 - 39
3. 40 - 59
4. more than 60

5. Which is your last year of studies?

1. School not complete
2. School complete
3. High school not complete
4. High School complete
5. University not complete
6. University Complete
7. Politechnical Institute
8. Did not go to school
9. Not reply

6. Do you live on your farm?

1. Yes on the farm
2. Also on a city
3. Also on Montevideo
4. No, on a city near the farm
5. No, on Montevideo
6. No, on another country .

7. If you do not live on your farm, how often do you go to the farm?

1. Every day
2. One or three days a week
3. One or three days a month.
4. Other, which ....
9. (live on the farm)

8. If you live on the farm, how often do you go to the town?

1. Every day.
2. One or twice a week.
3. One or twice a month.
4. Three or four times a year.
5. Only, sometimes.

9. Do you have some difficulties to go in or out your farm?(bad roads)

1. Yes 2. No

10. If you don not live on Montevideo, how often do you go to Montevideo?

1. Every week
2. One or twice a month.
3. Three or four times a year.
4. Once a year or less.
5. Never

11. Do you have off-farm activities.

1. Yes 2. No

12. If is possible indicate which?

1. Farm worker.
2. Worker in a city
3. Merchant
4. Auctioneer.
5. Industrial.
6. Professional.
7. Other, which....
8. Do not reply.
9. (Do not have off-farm activities)

II. Farm data.

13. Number of farm. ..../......../......./

14. Which are the main livestock breed on your farm?

1. Hereford.
2. Aberdeen Angus.
3. Crossbreeding. Which?..................
4. Other. Which?......................

15. How many heifers do you mate in the last year

16. How many cows do you mate last year?

17. How many live calf do you have in the last season?

18. Which are the main sheep breed on your farm?

    1. Merino
    2. Ideal
    3. Merilin
    4. Corriedale
    5. Romney
    6. Crossbreeding(Which)
    7. Other
    9. Do not have.

19. How many young ewes(2 teeth) do you mate this year?

20. How many ewes do you mate this year?

21. How was the number of lambs?

22. Which of the following things do you have in your farm?

    1. House
    2. Electricity from the government network
    3. Generator.
    4. Barn.
    5. Wind mill.
    6. Tractor.
    7. Water damps.
    8. Underground water.
    9. Other.
    10. Other.

23. How many paddocks do you have on your farm?

    Number:

24. In relation with the water damps, how many support the draught in 1988/89?

    1. All
    2. Some
    3. None

25. How deep they are?

    1. Meters:
    9. I do not know

26. The dumps are:

    1. With surrounding fences
    2. no fences

27. In relation with the underground water, haw many support the draught?

    1. All
    2. Some
    3. None

28. How deep they are?

    1. Meters:
    9. I do not know

29. How often do you count your livestock heads?

30. How many Kg. of wool do you shearing last year?

31. Where do you sold it?

    1. On the farm.
    2. Wool barrack.
    3. Cooperative
    4. Auction
    5. I do not sale yet.

32. How many animals do you sold this last year?

	Number of heads
Finish bullocks	________
Not finish bullocks	________
Calves before weaning	________
Calves after weaning	________
Fat cows	________
Cows for fat	________
Heifers	________
Sheep	________
Lambs	________
Rams	________

33. If you sold fat bullocks, How are the average weight?

Kg	________
Age(years)	________

34. Where do you mainly sold your finish livestock?

    Bullocks
    Cows

III. Problems, necessities and attitudes

35. Which of the following problems are presently in your farm?

1. Your farm do not produce enough pasture
2. Bad quality pasture.
3. The pasture distribution is not good
4. The stocking rate is very high
5. The stocking rate is too low
6. Low number of paddocks
7. Health problems
8. Problems with pastures management
9. Bad quality of the breeding.
10. Low fertility in the herd.
11. Not enough water places for the animals
12. Scarcity of labour
13. Weeds
14. Little forestry area for shadow and shelter.

36. Which of this problems are for you the most important.

1 ______________________________
2 ______________________________
3 ______________________________

37. Generally, farmers suggest that there are several factors with negative effect on the farm. In your case which of the following problems affect you

1. very much
2. a little
3. nothing

1. Size of the farm __________
2. Do not live in the farm __________
3. Problems for sold the products __________
4. Absence of good technology __________
5. Level of prices on livestock and wool __________
6. Level of prices of machinery and inputs __________
7. Bad roads. __________
8. Farness of the towns. __________
9. Credit availability __________
10. Taxes __________
11. Prices instability __________
12. Absence of good market information __________

38. Which are for you the most important?

1 ______________________________________
2 ______________________________________
3 ______________________________________

39. Do you use credits?

1. Yes 2. No

40. If you do use credits, what do you use it for?

____

____

____

41. Which institutions do you borrow from?

____

____

____

42. If you do not use credit, why?

____

____

____

43. Have you invested in some of the following items in the past 5 years?

Forestry
Fences
Watering places
Wind mills
Barns
More land
Pastures improvement
Machinery
Vehicle

45. Do you find that there is some important investment to do on the farm at the moment?

1. Yes, Which? ....
2. No

46. Do you agree or disagree with these:

1. On grazing livestock systems, improve the pastures is not profitable?

1. Agree
2. Disagree
3. Do not know

2. Improve pastures is very risky, because the probability of fail or loose is very high?

1. Agree
2. Disagree
3. Do not know

3. The farmer who invest in improve the farm, generally have a best performance if is compared with the traditional way of farm?

1. Agree
2. Disagree
3. Do not know

4. The main break to adopt new technology is the variability in the prices of meat and wool.

1. Agree
2. Disagree
3. Do not know

47. Which are for you the most difficult decisions:

1. production decisions
2. market decisions
3. both

48. How do you obtain information before decide when sale or buy?

____

49. Do you keep some production records?

1. Yes
2. No

50. Do you keep economic and financial records?

1. Yes
2. No

51. Do you have some professional advice in order to pay taxes?

1. Yes
2. No

52. If you have an unexpected increase or decrease on the prices of livestock or wool that produce an important increase in your income, on which of the following alternatives would you invest your money?

- buying animals
- buying more land
- improving the farm
- Saving money in the bank
- machinery
- pastures improvement
- Individual expenses
- other

53. Do you have some neighbour that you think is a very successful managing livestock grazing systems ?

1. Yes 2. No

54. Which are the main reasons of his success ?

55. Which of the following items define more clear your activity ?

- Stock-farmer
- Farmer
- Little Farmer
- Middle farmer
- Manager
- Employer
- Little employer

56. Do you think, your farm is going:

1. good
2. Regular
3. Bad

57. Why?

IV. Evaluation of technology transfer channels

58. Which of these two sentences is more near to your think:

1. Any farm can have a good running today if do not have technical advice.
2. A good farmer can manage perfectly his farm by himself.

59. Which of these two sentences is more near to your think:

1. Advice and technical support are good but expensive.
2. Instead of be expensive, advice and technical support are a good investment for the farm.

60. Do you have advice or technical support by an agronomist on your farm?

1. Yes
2. Yes, one of the partners
3. No

61. How often did you consult an agronomist this year?

____

62. If not, Why?

____

63. If 61 is yes, for which of this subjects?

- To negotiate a credit. ☐
- Pasture production ☐
- Livestock management. ☐
- Management ☐

64. If 61 is yes, what kind of support did you receive?

- Private ☐
- Cooperative ☐
- Farmers Group ☐
- State, "Plan Agropecuario" ☐
- State, Agricultural Ministry Department ☐
- Province-in ☐
- Other ☐

65. How often did you consult a Veterinary this year?

1. Yes How often? ________
2. No

66. Which subjects?

- Vaccination ☐
- Pregnancy diagnostics ☐
- Clinics ☐

67. According to your experience, technical support and advise is

- very important ☐
- important ☐
- not much important ☐
- not important, I do not receive ☐

68. Have you worked with "Plan Agropecuario."

1. Yes
2. No

69. If not. Why?

____

70. If 68 is yes, In which activity?

improve pastures
improve infrastructure(Buildings, fences, etc.)
Which ______________________

machinery
technical advise

71. During what period did you work with the plan?
indicate years
from. to

72. Did you find that was useful work with "Plan Agropecuario"

____
____

73. At the moment, do you find that is useful work with" Plan Agropecuario"?

1. Yes
2. No

74. Have you been on an Experimental Station?

1. Yes. Which

2. No

75. What are you interested on ?

____

76. Do you belong to any of the following institutions?

Cooperative	
Rural Association	
Rural Federation	
CREA group	
Breeding Association	

Other. Which ______________________

77. If you belong to a cooperative, which of the followings services do you use?

1. To buy inputs.
2. To sell wool
3. To sell livestock
4. Technical advice
5. Marketing advice

VI. Communication media

78. Which of the following elements do you have on your farm?

1. Phone
2. Phone-radio
3. Transmission-radio
4. TV
5. Parabolic Antenna(Long distance TV antenna)

79. For arrange business the phone is:

1. Very important
2. Medium important
3. Not much important

80. What do you use to inform?

Radio
TV
Newspaper

81. How often do you read newspapers?

every day
1 or 2 times a week
Sometimes
Never

82. Which of the following newspaper do you use to read?

El Pais
La Mañana
La República
Ultimas Noticias
Other newspaper . Which ____________________

83. Which radio do you use to listen to?

____

84. Do you use to listen to some agricultural programs?

Yes		Which ____________________
No		

85. Do you see TV.?

1. Yes	
2. No	

86. Which of the channels do you prefer?

1. 4
2 . 5
3. 10
4. 12
5. Local Channel
6. Argentine Channel
7. Brazilian Channel
8. Uruguayan Network

87. Do you use to see some agricultural program?

1. Yes, Agricultural Network Program
2. Yes, Agricultural Government network programs
3. Other
4. No

88. Do you use to read some agricultural magazine?

Yes ☐ Which ____________________

No ☐

V. Technology use

a. Animals management

89. On which month do you use to mate the cows?

From ________ To ________

90. Why do you choice this period?

____

91. At what average age do you mate the heifers?

____

92. At what average age do you wean the calves ?

1. 6 months
2. 7 month
3. 1 year
Other: ________

93. Why do you wean the calves at this age?

____

94. On which month do you use to mate the ewes?

From ________ To ________

95. Why do you choice this period?

____

96. At what average age do you mate the lambs?

2 teeth
4 teeth

97. At what average age do you wean the lambs ?

____

98. Why do you wean the calves at this age?

____

99. How often do you control the ewes during the birth period?

100. What kind of vaccination do you use to do?

Sheep:	Anthrax and gangrene	☐
	Ectima	☐
Cattle:	Foot and mouth disease	☐
	Anthrax	☐
	Bruceslosis	☐

101. How many anthelmintic dose do you use on:

Sheep ☐

Cattle ☐

Animal feed

102. Do you use to move the livestock among different paddocks?

1. Yes
2. Not

103. Which kind of animals do you use ?

____

104. Do you use electric fence?

1. Yes
2. No

105. Do you use to give some feed to the animals?

1. Yes
2. No

106. Do you give salt to the livestock?

1. Yes
2. No

107. Do you supplement the animals with grains?

1. Yes
2. No
3. Only on the draught on 1988/89

108. Do you use some method for forage conservation?

1. Hay
2. Silage
3. Other Which ______________________
4. No

109. Do you have some health problem on your farm?

Yes		Which	
No			

110. What is the origin of the bulls do you use on your farm?

Produced on the farm
Lend for other farmer
Other

Pastures management

111. Do you do some adjustment in the stocking rate in function to the pasture availability?

1. Yes
2. No

112. If you do, How do you do?

1. Animals sold
2. Moving the animals to other paddock
3. Other. [ ] Which [ ]

113. If you compare the state of the natural grassland today against the state 20 years ago is:

1. Better
2. worst
3. equals
4. I do not know

114 . If you observe changes, what are the main reasons?

____

Do not know

115. Which problems do you have with the natural range lands pastures?

____

None

116. Do you use some method for improve the natural pastures?

1. Yes 2. No

117. If 116 is yes, Which methods do you use?

____

118. If 116 is yes. where do you find the information related with these improvements?

1. Communication media
2. neighbours
3. Adviser
4. Field days
5. Other

119. Which animals do you use in the best quality pastures?

____

120. Do you have enough information for manage the pastures improvements?

1. yes
2. no

121. If 120 is yes, What subjects do you need to know better?

____

122. Why do you prefer extensive improvements in the pasture rather than conventional improvements?

____

123. Do you think that the result of the pasture improvement methods is

good
regular
bad

124. Why?

____

125. Why you do not invest in improve pastures?

____

126. Did you never invest in pastures?

1. Yes
2. No

127. If yes. in what year?

____

128. Do you do conventional pastures improvements?

1. Yes
2. No

129. Since what year do you use conventional pastures improvements?

____

130. If 128 is yes. where do you find the information related with these improvements?

1. Communication media
2. neighbours
3. Adviser
4. Field days
5. Other

131. Why do you adopt this method of improve pastures?

____

132. Which categories of animals do you use in the improvement pastures?

____

133. How long they are productive?

years [ ]

134. What are the main problems with this improvement?

____

135. Do you have enough information related with this method?

1. Yes
2. No

136. If 135 is no, what information do you need?

____

137. Do you like to increase the area with improve pastures?

1. Yes
2. No

138. If 137 is not, Why not?

____

139. Do you think the technology of improve pastures is profitable?

1. Yes
2. No
3. Do know.

Appendix 7 (Chapter 7)

Appendix 7.A.

7. Results analysis.

7.1. Farmer and Household Features.

Thirteen variables which describe some of the main socio-economic features relating to the groups were analysed (Table 7.1). Considering the significant and non significant variables among the three groups, it is possible to identify the characteristics which differentiate FD-MUs and the variables which are common to the three groups (Addendum; Tables 7.1 to 7.12). The age of the farmer, the age of the youngest child, the mechanisms of property transfer and the size of the farm are the variables that show statistically significant differences among the groups studied. This information suggests that age and property transfer are important variables in differentiate groups of FD-MUs. Formal farmer education, farming experience, size of the family, ownership, farmer and family residence place, and off-farm activities are not significant among groups indicating some differences with the results obtained for the whole sample analysis.

7.1.1. Age of the farmer and youngest child.

The age of the farmer and the age of the youngest child are broad indicators of the age of the family. Significant differences among groups were found, indicating that FD-MUs of Group 3 are integrated for relatively younger farmers (Addendum; Tables 7.1 and 7.2). The age of the youngest child is an important feature when studying household features and family cycle because it is associated with the economic independence of the children.

For this reason it was considered convenient to divide the ages of the youngest child into four categories.

Table 7.1. Farm and Household features, showing levels of significance between groups.

Socio-economic Variables	Level of Significance
Age of the Farmer	*
Age of the Youngest child	*
Property transfer	**
Size of the Farm	3**/1,2
Education	NS
Farming Experience	NS
Size of the Family	NS
Ownership	NS
Farmer -place of residence	[2]
Family -place of residence	[2]
Off-Farm Activities	NS
Reasons to have an off-farm activity	NS
Type of off-farm activity	NS

The first category is between 1 and 9 years old, when children mainly depend on the father's and mother's income to live and require more attention from the family. The second category is between 10 and 19 years old, when young people start to become independent from the family and require less attention from the family. The third category is between 20 and 29 years old, when young people are becoming independent from the family or getting involved in farm work.

The fourth category is where these are children over the age of 30, who are almost totally independent of the family or when they are starting to transfer to the farm business. Looking at the entire family cycle process on this Type of FD-MUs information suggests that the farmer takes over between 30 and 40 years old and retires sometime after the age of 60. Each generation stays working and taking

[2] Too many cells with zero value not suitable for χ^2 test.

[2] Too many cells with zero value not suitable for χ^2 test.

decisions on the farm over a period of between 30 to 40 years. Looking at farmers' experience, in Group 3, 57.1 percent of the farmers have less than 20 years farming whilst 61.3 and 78.6 of farmers in Group 1 and Group 2 have more than 20 years farming. There are, therefore, relatively more young farmers in Group 3.

7.1.2. Family cycle and transference of property

According to Boehlje and Eidman (1983) the family-firm life cycle has three main stages, (i) *the entry or establishment stage*,(ii) *the stage of growth and survival* and (iii) *the exit or desinvestment stage.* According to the authors, in the last stage two main processes are involved; the process of retirement and the intergeneration transfer of the property, where the farm property and the managerial responsibility of the farm are transferred to the next generation.

Families of Group 3 are younger than the families in the other groups and thus they are mainly situated between the first and the second stage. In the case of Group 2, the families will mostly be in the second stage and, in the case of Group 1, farms are in the third stage .

In analysing how the property is transferred to the next generation, it is necessary to confides the intergenerational transfer of the farm and the family, which shows how the farmer obtains or gains access to the control of the farm resources. In almost all the groups the main route to access to the resource control is by some family relationship (Addendum; Table 7.3) Some farmers in Group 3 obtain control by a partnership or salaried job as in the case of a manager. That means people enter the farming business with the main task of managing the farm. These farmers of Group 3 who are the younger farmers and have the youngest FD-MUs (wife or partner and children) also own the biggest farms and therefore have the largest amount of capital in land (Addendum; Tables 7.1, 7.2 and 7.38).

7.1.3. Farmer and family place of residence

Related to the residence of the farmers and their families, results range between Group 3, where 71.4 percent of the farmers reside off the farm and Group 2, where 57.1 percent reside off the farm. Only 13.6 and 14.3 percent of farmers in Groups 1 and 3 live on the farm (Addendum; Table 7.8). Farmers' families live mainly off the farm and results range between 90.9 percent in Group 1 to 78.6 percent in Group 2 (Addendum; Table 7.9). This information indicates a high urban orientation by all the farmers which is most likely explained by the availability of better services and education facilities in the cities.

7.1.4. Off-farm activity

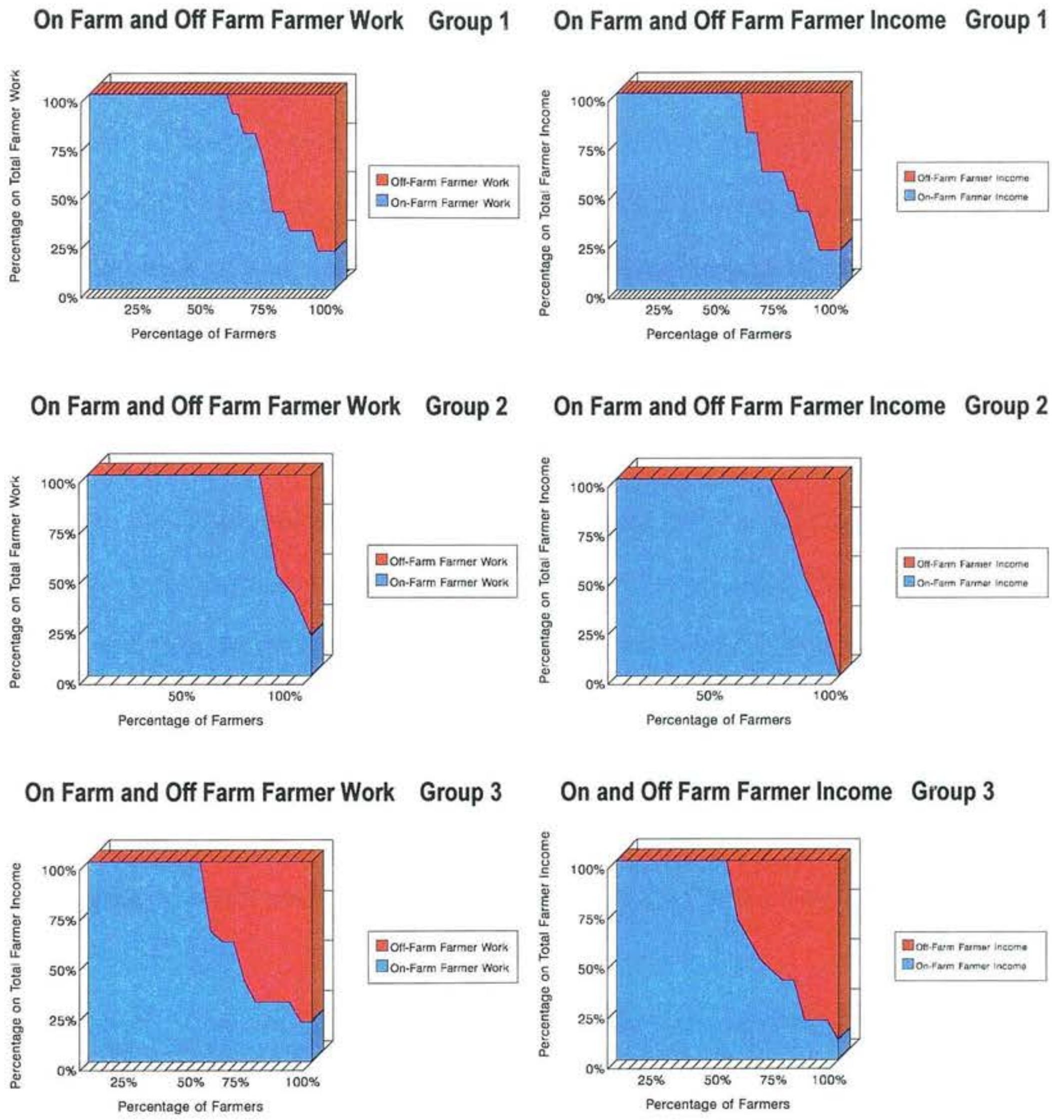
Despite the whole survey analysis was found a strong association between age and education with off- farm activities (Addendum; Tables 6.14 and 6.15), no significant difference was found among groups (Addendum; Tables 7.10, 7.11 and 7.12). In Group 2, 78.6 percent of the farmers reply that they do not have an off-farm activity. In groups 1 and 3, 45.5 percent and 42.9 percent of the farmers have off-farm activities (Addendum; Table 7.11).

It is necessary to consider the reasons to have an off-farm activity; in the case of Group 1, 18.2 percent of the farmers have an off-farm activity in order to meet expenses. Farmers answer that the income obtained from the farm activity is not enough to cover the household and farm costs. The 78.6 percent of farmers in Group 2 are mainly dedicated to the farm and answer that the off-farm activity is not significant. The 14.3 percent answer that they have an off-farm activity because it is complementary with the on-farm work. Just in one case a farmer lives mainly on the income from the off-farm activity, and the explanation is that he is investing all the earnings of the off-farm activity on the farm. In the case of Group 3, 23.8, percent of the farmers answer that they have an off-farm activity because it is complementary with the on-farm activity.

In order to have more evidence about off and on-farm work, interviewees were asked about how much of the total income comes from the farm and how much of their working time is dedicated to the farming activities (Figure 7.1).

Despite there being no significant difference among groups concerning off-farm work and income, it is still possible to appreciate that in the case of groups 1 and 3 the off-farm work and income represent an important part of the total work and income of the farmer. According to the interviews, in both cases they have more diversified sources of income. In the case of Group 1, the off-farm activity has the aim of covering the expenses and diversifying income, while in the case of groups 2 and 3 farmers have an off-farm activity as they are looking for complementary work. The explanation can be found in these figures: 54.5 percent of the farmers in Group 1 manage farms that are in the smallest size stratum, 200-999 hectares (Addendum; Table 7.38) while farmers of Group 3 have the largest farms, 71.4 percent manage farms larger than 2500 hectares, and the farm income could be enough to cover farm family expenses. Farmers of Group 2, are the most dedicated and dependent on the farm income and work.

Figure 7.1. On and off farm farmer work and income by group membership



7.1.5. Formal education

The formal education level is relatively high in all groups and there is no significant difference among groups (Addendum; Table 7.4). Group 1 has the highest percentage of farmers with primary incomplete (22.7 percent). Nevertheless, looking at the modal values, in Group 1 the mode 25.0 percent is farmers who have completed high school, in Group 2 42.9 percent of farmers in the polytechnic and other categories, and in Group 3, 33.3 percent of farmers have completed university.

According to the information presented, the variables that differentiate FD-MUs, are related to the family cycle, intergenerational issues and the size of the farm, like an indicator of the economic status. That means that the younger FD-MUs of Group 3, control and take decisions on the largest farms and some of them have access to the land through a partnership or paid function such as a manager and this is where the off-farm activities have the highest modal value.

7.2. Farmers' main sources and use of information for support decisions

Information is one of the most important factors to consider in order to better understand the decision making process. The process that transforms information into action is decision making. Ten variables were selected in order to explore if there are some differences between the main sources, flows and groups of information used by farmers to make decisions (Table 7.2) and in this way depict the main sources of information considered at the FD-MUs level and provide information to test hypothesis 1.

Table 7.2. Main sources and use of information variables, showing χ^2 level of significance.

Variables	Level of Significance
Main sources of information	NS
Farmers search field for prices	NS
Main reasons to keep records	**
Farmers' main use of records	*
Farmers' knowledge of production costs	**
Farmers' key information for support decisions	NS
Farmers' type of information for support decisions	**
Differential use of informal and formal information	**
Main use of formal information	**

In general, among groups, the significant differences are associated more with how farmers use and process the information which they have obtained, rather than with the availability of main sources, search field or key information for support decisions.

Nevertheless it, was considered important to identify the main sources of information in each group (Addendum; Table 7.16). In the case of Group 1, the most important sources are brokers and auctioneers (B & A) (29.5 percent), the family (25.0 percent), and the mass media (20.5 percent). In Group 2, advisers (28.6 percent), B & A (21.4 percent) and family (21.4 percent) and in Group 3, B & A (23.8 percent), advisers (19.0 percent) and mass media (19.0 percent). The information suggests that in the case of Group 3, farmers have a more entrepreneurial attitude since the main sources are related to market information (B & A), advisers and mass media. In the case of Groups 1 and 2 the family is one of main important sources and, therefore, the farmer adopts the values of the farm business.

Although there are not significant differences among groups, in the search filed for prices, the 65.9 and 71.4 percent of farmers in groups 1 and 2, keep to a routine of purchasing from the usual supplier while in Group 3, 52.4 percent of the farmers search for prices before purchase (Addendum; Table 7.17). This information suggests that farmers in Group 3 have a more entrepreneurial and market orientated behaviour. The other important fact is that for 93.6 percent of the farmers the search field is at local level.

However, there are differences among the groups in terms of reasons to keep records, the main use of information, the knowledge of production costs and the type of information used for support decisions (Addendum; Table 7.18 to 7.20 and 7.21 to 7.25).

Farmers of groups 2 and 3 have some common characteristics which differentiate them both from farmers in Group 1. In both cases (50.0 and 52.4 percent respectively) most of the farmers keep records because they need information to manage their farms while the majority of farmers in Group 1 (56.8 percent) keep records because it is compulsory. Farmers of groups 2 and 3 are relatively more keen to know their production costs and they mix formal and informal information in order to support their decisions (Addendum; Table 7.23). Farmers of Group 1 use mainly informal information for support decisions (70.5 percent), while farmers of Group 2 and 3 use relatively more formal information. During the interviews they said that they need to use formal and informal information to support different decisions (50.0 and 76.2 percent respectively) and when to use more of one or the other depends on the type of decision to be taken(Addendum; Table 7.24). Formal information is used more for planning, investments and loan decisions (Addendum; Table 7.25). If the decision is associated with market prices (buy and sell) then it is necessary to obtain 'fresh information' to take decisions and the source is usually informal. The formal information is mainly used to give a framework to more effectively use the informal information.

The argument given by some farmers is that formal information can be a good support and explanation for decisions that are not totally new and where a previous standardised knowledge already exists. The blend of how much use of formal or informal information to support decisions always depends on the circumstances. One of the farmers said *'Formal information is necessary to know where we stand now and informal information to know where we shall step next'*

The presented information shows that farmers' behaviour ranges between: (i) farmers of Group 3, relatively young farmers, who own the largest farms, have a more entrepreneurial behaviour and use formal and informal information to support their decisions to (ii) farmers in Group 1 who support their decisions mainly on informal information, These farmers have little knowledge about their production costs, and are mainly looking at market prices of their products and do not have a differential use of information. This shows that information as a resource, is asymmetrically distributed and used among the three groups. Information suggests that farmers can never have prefect information and therefore they try to satisfy their objectives searching for the most favourable condition locally rather than globally.

7.3. Farmers' decision support and use of analysis

It is also important to discover how the information is processed in order to explore different patterns of behaviour between FD-MUs. Results show that there are significant differences among groups (Figure 7.3) Farmers in Group 1, that prefer to base decisions mainly on intuition (50 percent) farmers of Groups 2 and 3 prefer to base their decisions on intuition and analysis (71.4 percent and 57.1 percent respectively) (Addendum; Table 7.26).

Table 7.3. Farmers decisions and analysis variables, showing χ^2 level of significance.

Variables	Significance
Farmers' use of intuition or analysis	*
Farmers' decisions that require more analysis	NS
Farmers' decisions that they think need advice	NS
Decisions that farmers' think need to concentrate effort	--

No significant differences were found to determine which the decisions require more advice and on which the farmers think they need advice (Addendum; Tables 7.26 to 7.29). There were general agreement that decisions about investments and loans require more analysis and that farmers need to concentrate their attention on production and technical decisions. This evidence shows that FD-MU, despite the differences on behaviour related to some topics (some are more entrepreneurial and some more family oriented) their main interest it is in decisions related to the physical production rather than maximise income.

7.4. Farmers and computers use

The use of computers is an indicator about the facilities available in order to support the FD-MU to analyse and process information. Significant differences between groups was found between farmers who own a computer and others (Table 7.4). The situation ranges between farmers in Group 1, where 93.2 percent do not have a computer and farmers in Group 3, where 47.6 percent of farmers have a computer.

Table 7.4. Computers on farm and their use, showing χ^2 level of significance.

Variables	Significance
Farmers who own a computer	**
Farmers' reasons to manage without a computer	**
Use of computers on the farm	**

In Group 1 the main reasons for not having a computer are a lack of understanding or no interest (40.9 percent), and because it is not justified. In Group 2, the main reason is because farmers have other priorities (28.6 percent) and in Group 3, the main reasons is a lack of understanding. Nevertheless, 47.6 percent of farmers of Group 3 own a computer, but 33.3 percent use the computer for support farm decisions. The information presented is concordant with some of the reasons given by some farmers in Group 1;

> *"computer could be useful for large farms, where the amount of information is also large, but in the case of small or medium farms, I do not think it is justified, given there are other important constraints, like capital availability"*

Nevertheless, this information is important to bear in mind to have an idea of the scope that programming computerised decision support systems can have at farm level.

7.5. Knowledge communication

Significant differences were found among groups in the acquisition and acceptance of ideas from other farmers (Table 7.5). The results range, between farmers in Group 1, where 29.6 percent of the farmers do not acquire ideas from other farmers to farmers of Group 2, where 100.0 percent of the farmers acquire ideas from other farmers (Addendum; Table 7.33). Related to the acceptance of their ideas from other farmers, the situation ranges between 54.5 percent in Group 1, to 81.0 percent in Group 3 (Addendum; Table 7.34).

The results suggest that FD-MU integrated by farmers of groups 2 and 3 are more inclined to exchange their experiences with other farmers in order to acquire knowledge to improve their practices. In Group 1 they are relatively less keen on exchanging ideas and the self perception of themselves it is not very high, because 45.5 percent of the farmers think that other farmers do not take their ideas.

Table 7.5. Farmers' communication variables, showing χ^2 level of significance

Variables	Significance
Acquisition of ideas from other farmers	*
Acceptance of ideas by other farmers	*
Farmers' more useful communication source	NS

No significant differences were found, concerning more useful communication sources of farming practices. In all the groups, the exchange of ideas with other farmers and the exchange of ideas with advisers are highlighted as the most useful. Experience and the exchange of knowledge with farmers and advisers are important ways of communication of local knowledge about farming practices of the FD-MU.

7.6. Farm organisation

Significant differences were found among groups related to farmers' self perception of their farm organisation (Table 7.6 and Addendum; Table 7.36). Farmers' perception of their actual farm organisation ranges between a mainly family organisation in Group 1 (79.5 percent), to a more entrepreneurial organisation in Group 3 (38.1 percent) (Addendum; Table 7.36). No significant differences were found in the answers to the question about what is the organisation they think is better for farming (Addendum; Table 7.37).

The information presented suggests that FD-MUs of Group 1 are more organised like a family business while the perception of FD-MUs of Group 2 and 3, is more inclined to perceive the farm as an entrepreneurial activity.

Table 7.6. Farm organisation variables, showing χ^2 level of significance

Variables	Significance
Actual farm organisation	**
Farm organisation they think is best	NS

7.7. Farmers' formal activities planning

Significant differences were found among groups when farmers were asked about the frequency and period of formal planning activities (Table 7.7). Results vary between 59.1 percent of farmers in Group 1, who almost never plan their activities to farmers in Group 2 where 78.6 percent of farmers almost always plan their activities (Addendum; Table 7.38 and 7.39). The majority of farmers in Groups 2 and 3 agree that some formal planning is necessary but they have differences in the period of planning activities. The majority of the farmers of Group 2 consider that the period needed in the plan is one year while farmers in Group 3 mainly consider that a period of between 1-6 months is necessary. Farmers of Group 3 said that detailed planning for a period longer than 6 months or 1 year is a waste of time. Changes in the working environment are so common that, in order to take actions to maintain the original plan, it practically requires the development of a new plan.

Farmers of Group 2 and 3 also are not continuously planning changes in the whole production system each year. Rather they are mainly interested in changes that partially affect the production system. They mainly plan the tasks which develop during the year and they introduce mainly small changes. In this way coexist the routines plan, that covers the risks with the new gradual changes. In the case of farmers of Group 1, they prefer to have a "mental" plan also based on the experience. But these farmers are not very interested in changes and, therefore, they apply almost the same sequence of practices and tasks every year. This routinised behaviour is integrated for a set of different routines and rules and constitutes their mental plan. These routines, based on past experience, are repeated year by year until a change in the working environment forces them to change.

Table 7.7. Farm planning activities variables, showing χ^2 level of significance.

Variables	Significance
Frequency of planning activities	**
Period of planning activities	**

The presented information suggests that all farmers have a flexible "mental" plan to handle planning activities, that in Groups 2 and 3, it is more supported by formal planning activities. The period of planning is generally no longer than one year.

7.8. Production system description

Twenty three variables were selected in order to describe the main production systems features among groups. The selected variables can give an indication about the main production system activities, the management resources, facilities, rules, strategies and technology used to drive the production system. Taken across the significant and not significant variables, among the three groups, it is possible to find that significant differences in variables related to technology use and systems orientation are dominant to the non significant. That indicates that, farmers classified in each of the 3 groups manage different Types of production systems.

7.8.1. Production system orientation

The main preferred system in the whole region analysed is mixed grazing of cattle and sheep and there are not significant differences among groups (Addendum; Table 7.42). Significant differences were found in the system orientation on beef cattle and sheep production. The cow-calf activity is predominant in Group 1 (43.2 percent), and complete cycle is predominant in groups 2 (50.0 percent) and 3 (47.6 percent) (Addendum; Table 7.43). Also finishing in Group 2 and other activities such as seed stock farm in Group 3 had relatively more relevance. Farmers were asked about the rural knowledge acquired and in particular about the pasture quality required for cow-calf, complete cycle, finishing and seed stock farm activities. According to rural people, paddocks with highest pasture quality and fertility need to be destined to finishing, and, seed stock activity, but in the latter case is best to complement natural pasture production with improved pastures. Medium quality pasture paddocks need to be used for growing animals and the worst to cow-calf activity.

Table 7.8. Production system orientation, showing χ^2 level of significance

Variables	Significance
Farmer preferred working system	NS
Main activity on beef cattle production	*
Main activity on sheep production	**
Sheep cattle ratio	**

In sheep production, there is a marked preference by farmers of Group 3 for complete cycle activity (Addendum. Table 7.44).

In order to aid on understanding of the different systems, some general farmers' opinions are presented. These are taken from farmers' interviews and reflect some general knowledge of rural people relevant to the farm management.

Rural people argue that in general, the activity with most status and prestige for farmers is seed stock farm. Beef cattle finishing based on buying all the calves to fat is the most profitable, but also the most risky activity, because it requires high levels of capital and the variability on the prices of a kilogram of fat and thin animals. Complete cycle is less profitable than finishing but it is more safe and less risky. Cow calf activity has the lowest profitability and low risk. In the case of sheep the profitability is directly associated with wool prices. If the wool price is high farmers say that the most profitable activity is complete cycle with a high percentage of rams, because it is associated with higher wool productivity.

However, one of the most important issues that defines the whole system orientation is the sheep/cattle ratio. The relationship of sheep to cattle is one of the most important in determining the type of system. The relation between sheep and cattle with the pasture production resources, could be competitive or complementary and management decisions for the one affect the other in a positive or negative way. In Uruguay, a combination between a complementary and competitive relationship exists and the relative proportions of each depend on internal and external factors like type of soil and prices.

The information acquired suggest that one of the main reasons to graze sheep and cattle together is to diversify income to prevent risk and because soils in the basaltic area are considered more suitable for grazing systems rather than intensive agricultural systems with rotational crops.

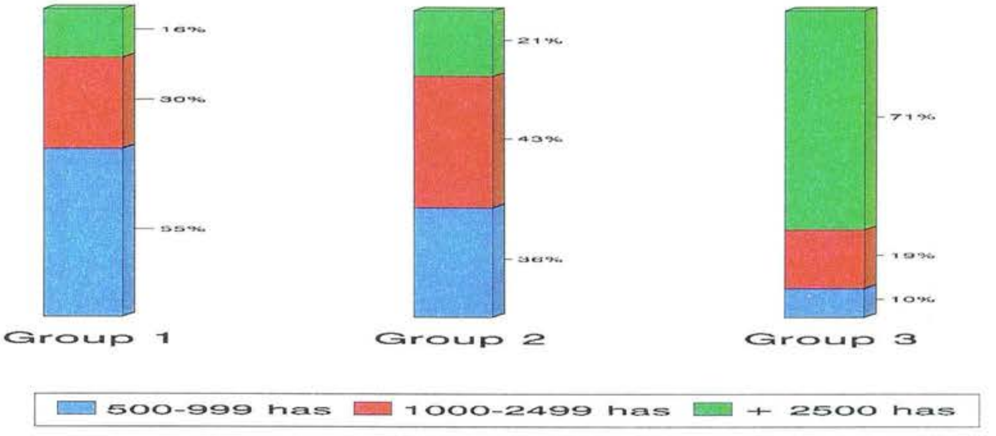
7.8.2. Production system management description.

The main variables related to the production system and management resources, facilities, rules and strategies are presented in Table 7.9.

Size of the Farm

In relation to the physical size of the farm, there is a major difference among groups (Figure 7.10). In Group 1 there is a high percentage of relatively small farms; 55 percent of the farms have a surface of less than 999 has and only 7 percent of the farms are greater than 2500 has (Addendum; Table 7.40). In the case of Group 2, 43 percent of the farms are between 1000 and 2499 has. In Group 3, the highest percentage (71 percent) corresponds to farms with more than 2500 hectares and only 2 percent correspond to the first stratum.

Figure 7.10. Size of the farm and Group membership.

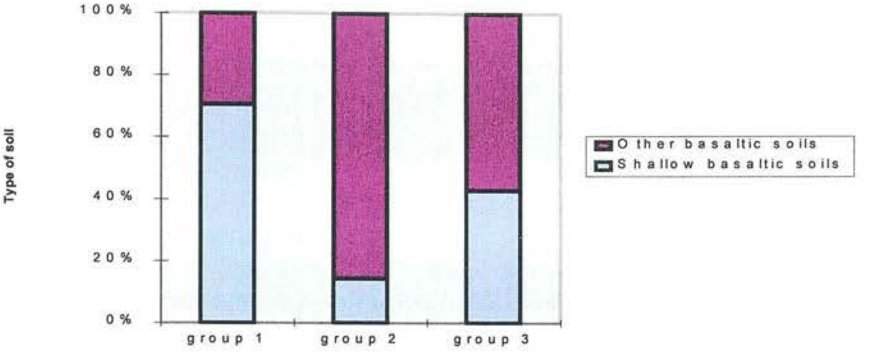


Soil type and main activity on cattle and sheep

Soil suitability is an important characteristic associated which the differences among groups (Figure 7.11). Farmers of Group 2 had the major percentage of deep soils (85.7 percent) (Addendum; Table 7.41). In Group 2 the finishing activity for cattle production is higher (21.4 percent) (Addendum; Table 7.43) These farmers also had the highest percentage of land with improved pastures (7.8 percent) and crop lands (7.0 percent) and also higher cattle and total stocking rates, 0.41 and 0.87 AU/ha[1] respectively (Addendum; Table 7.45).

[1] Animal Units per hectare. The cattle livestock requirements of one head, were estimated as 0.75, that correspond to the DICOSE regional average for a complete cycle with all the categories. In the case of sheep and horses the DICOSE standard was used for estimate the requirements of one animal head, 0.2 and 1.2 respectively.

Figure 7.11. Farms by agroecozone and group membership.



Despite there being no significant differences among the percentages of weaned cattle and sheep, the highest percentages are in Group 2, 60 percent in cattle and 72 percent in sheep.(Addendum; Table 7.45)

These findings confirm the knowledge acquired by rural people that, on the best pastures and soils, the best option is to have cattle and, within the entire cattle production process, to emphasise the finishing section. They reserve the more shallow and stony soils for sheep production. According to rural people, is the situation where the type of soil and pasture associated makes it impossible to finish cattle or to have a complete cycle, then the only alternatives are to have cow-calf or high sheep stocking rate. When farmers were asked about the main use of their best pastures, 90.5 percent of farmers of Group 3 answer finishing animals, compared with 63.6 and 64.3 percent of the farmers of Group 1 and 2 respectively (Addendum; Table 7.52).

Table 7.9. Production system management indicators, showing χ^2 level of significance.

Variables	Significance
Size	3**/1,2
Type of soil (Agroecozone)	**
Main seasonal production bottle neck	NS
Main strategy to cope with production identified bottle neck	**
Inclusion of a new feeding practice in the future	*
Number of paddocks	1**/2**/3**
Use of electric fence	**
Percentage of improved pastures	1**/2**/3**
Percentage of cropped land	NS
Winter supplemenattion with grain	*
Use of best pastures to finish animals	*
Main objectives with pastures	**
Pasture quality rule base	NS
Pasture management rule base	NS
Animal management rule base	NS
Stocking rate	NS
Weaning percentage on cattle	NS
Weaning percentage on sheep	NS
Frequency of counting animals	**
Labour needs	**

On the other hand, the farmers in Group 1 had mainly shallow soils, and the sheep cattle ratio and the cow-calf activity are both higher (Addendum; Table 7.45). This suggests that farmers with high rates of cow-calf and sheep-stocking are associated with shallow soils and with a low percentage of improvements and crops lands. The lowest weaning percentages obtained correspond to Group 1. In the case of Group 3, is noticed that the sheep/cattle ratio is lower (3.9) and the total stocking rate is lower (0.78). The level of these indicators in Group 3, are between the levels of Group 1 and 2 (Addendum; Table 7.45). Farmers of Group 2 and 3 had the control of the best soil resources. The type of soil is a significant variable, showing that the potential associated with the resource soil has a strong association with the type of production system.

Main seasonal production bottle neck

Farmers were asked about what they considered to be the main seasonal production bottle neck for animals and pastures on their farms. Winter was identified as the main bottle neck and significant differences were found among groups (Addendum; Table 7.46).

Significant differences were also found relating to the main strategy followed to cope with this identified bottle neck and relating to any new practices in the future to avoid this seasonal bottle neck (Addendum; Tables 7.47 and 7.48).

- Group 1: A high percentage of farmers (40.9 percent), do not have any special management to cope with the winter bottle neck. If it is possible some of them agist (22.7 percent) or reduce the stocking rate by selling animals. They argue that there is a natural control and that it is not possible to know in advance if the winter is going to be good or bad. They have a routine that is not changed and which is applied every year. These farmers believe that economic performance and production are mainly associated with climatic conditions. The information indicates that the strategy of this Group is mainly to refrain from farm investments. Information suggests that they had a relatively satisfied and deterministic behaviour. 38.6 percent of these farmers also do not expect to include any improvement in the future (Addendum; Table 7.48).

• Group 2, 64.3 percent of the farmers improve pastures or seed forage crops. 92.9 percent of the farmers are considering including some new practice for animal feeding in the future. The information presented suggests that the strategy of these farmers possibly is to improve the farm productivity in a sustainable way.

• Group 3, 42.9 percent of the farmers improve pastures and 23.8 percent sell animals to reduce the stocking rate. 81.0 percent of the farmers are considering including a new practice in the future. According to the information presented the strategy of these farmers possibly is a gradual improvement selling animals according to market variations.

Management facilities and rules.

The facilities and practices that farmers use to manage pastures and animals are shown by the percentage of the area improved with pastures, the use of electric fences; the use of supplements in winter for feeding the animals, and the number of paddocks. These practices are also an indicator of the level permeability to incorporate technical changes of the farmer. These variables are associated with more or less controlled or more extensive or intensive production systems. The number of paddocks, use of electric fence, percentage of land with improved pastures, winter supplemetation, use of the best pastures, main objectives with pastures and the frequency of counting animals, have significant differences among groups (Table 7.10).

• Group 1: The majority of farms in this group have less than 6 paddocks (72.7 percent) with an average of 5.7 paddocks per farm. To manage animals and pastures, 86.4 percent of the farmers do not use electric fences (Addendum; Tables 7.49 and 7.50). They only had 1.1 percent of the land with improved pastures (Table 7.45). Farmers do not supplement feed for animals in winter (63.6 percent) and 36.4 percent supplement animals during the drought. Most of the farmers (63.6 percent) think the best pasture needs to be allocated to finishing animals, and the rest think that it is better to use the best pasture with calves, lambs or pregnant cows (Addendum; Tables 7.51 and 7.52). Their objectives with pastures are to feed animals (38.6 percent) and to maintain the natural grasslands (29.5 percent) (Addendum; Table 7.53). The majority of the farmers count animals every month (52.3 percent) but 38.6 percent are accustomed to count animals at intervals longer than two months (Addendum; Table 7.58) .

• Group 2, The average number of paddocks per farm is 9.9 and 35.7 percent of the farms have more than 10 paddocks. The majority of the farmers (57.1 percent) use electric fences for animals and pasture management. They have the highest percentage of land improved with pastures (7.8 percent) (Table 7.45). Only 14.4 percent of the farmers are accustomed to supplement animals with grain in winter, but 42.8 percent had supplement during the drought. Similar to Group 1, these farmers think that the use of the best pasture is for finishing animals. However, 35.7 percent think that the best pasture can be used to help weak animals, and in this way avoid animal deaths. Also they think that can be used with pregnant cows, or calves or lambs (Addendum; Tables 7.51 and 7.52). For them pasture is for feeding animals (71.4 percent) (Addendum; Table 7.53). These farmers had a very close monitoring of the production system, given that 78.6 percent of the farmers count the animals every month (Addendum; Table 7.58).

- Group 3, The majority of these farms (76.1 percent) have more than 10 paddocks and the average number of paddocks per farm is 16.4. Most of the farmers (71.4 percent) do not use electric fence for animals and pasture management. The percentage of land improved with pastures is 4.1 percent (Table 7.45). Only 9.5 percent of the farmers supplement feed for animals with grain in winter, but 52.4 percent had supplement during the drought. These farmers think that the use of the best pasture is for finishing animals (90.5 percent) (Addendum; Tables 7.51 and 7.52). These farmers consider that good pastures should be used to feed animals (66.7 percent) and to improve the soil (19.0 percent) (Addendum; Table 7.53). Only 42.9 percent of these farmers count the animals every month, perhaps because they have large herds and farms (Addendum; Table 7.58).

No significant differences among groups were found relating to the criteria used to determine pasture quality and the rules used for pasture and animals management. The main criteria to determine pasture quality is the animals' weight increase and the availability of legumes. The pasture management is based on the pasture height and the availability of green pasture. The main rule for animal management is based on score condition (Addendum; Tables 7.54 to 7.56)

As a result it is possible to appreciate that the highest degree of control and improved systems are managed by farmers in Group 2, followed by Group 3. Farmers in Group 1 have the least controlled production systems.

Labour needs.

The need for labour is an important indicator in order to define a production system. In some cases the farm operates only with family members, and in others full time labour or seasonal labour is required. Some typological studies divide farms between family and entrepreneurial farms using labour as a classification variable.

The use of permanent and seasonal labour shows statistically significant differences between among groups (Addendum; Table 7.45) The average number of permanent workers in Group 1 and 2 is 2.7 and 4.4 respectively and in Group 3 is 8.6

7. 9. FD-MUs behaviour to changes

13 variables were selected to explore farmers' attitudes and behaviour when confronted to changes (Table 7.10). Some of these variables represent the attitude of the farmers. Other variables are related to what farmers are really doing. A significant level of association was found among groups on seven variables.

- Group 1: The majority of FD-MUs (72.7 percent) are not interested in diversification, credit use (63.6 percent), agronomic advice (81.8 percent), or the latest technology (86.4 percent). Also 59.1 percent have not carried out any farm improvement in the last years, 70.5 percent have never used the public extension services and 84.1 percent have never visited a research institution (Addendum; Tables 7.13 to 7.15, 7.58, 7.61, 7.64 to 7.67). In other words these FD-MUs do not respond to changes with innovations in their farming practices.

- Group 2: In this group a large proportion of the FD-MUs (78.6 percent) are interested in diversification on their farms, use loan (57.1 percent), receive agronomic advice (71.4 percent) and are interested in the latest technology (78.6 percent). Furthermore, 92.9 percent had improved their farms in the last years, 64.3 had been working with the public extension services and 64.3 had visited research institutions. These FD-MUs appears to be proactive, being enthusiastic and aware on changes and new technology.

- Group 3: The predominant behaviour of FD-MUs of Group 3 can be seen in the interest in farm diversification (66.7 percent), the absence of credit (81.0 percent), the use of agronomic advice (67.1 percent) and the absence of interest in the latest technology (57.1 percent). These FD-MUs had improved their farms based on private advice, because 81.0 percent had never used the public extension services and 61.9 percent had never visited a research institution.

The results suggest that there are three different types of behaviour of the FD-MUs when faced to changes. The predominant type is in Group 1, where the majority of the FD-MUs are. These FD-MUs are mainly reluctant to adopt changes in their farming systems. On the other hand, FD-MUs in Groups 2 and 3 show a positive attitude to adopt and incorporate changes in their farm systems. Nevertheless, the strategy followed to implement these changes is different. FD-MUs in Group 2 have a propensity to use loan and public extension services whereas FD-MUs in Group 3 have the opposite view. The FD-MUs of Group 3 have a greater propensity to seek private advice

Table 7.10. Farmer attitude to changes variables, showing level of significance.

Variable	Significance
Interest in farm diversification	**
Planning changes in beef production	NS
Planning changes in sheep production	NS
Loan use	*
Labour as a constraint to introduce changes	NS
Use of advice	NS
Use of agronomic advice	**
Use of veterinary advice	NS
Perception of new technology	NS
Interest in applying the latest technology	**
Farm improvement in recent years	**
Use of public extension services	**
Agricultural research institution visits	**

That could be explained because they manage large farms, and they can work with their own capital, avoiding the use of loan and waiting to see results of the latest technology on other farms. FD-MUs in Group 2, on the other hand, possibly do not have enough capital to afford the investment in their farms and are more interested in implementing straightaway the latest changes. It is, however interesting to note that when interviewees were asked whether they thought that new technology was necessary to compete in the market place, more than 90.0 percent answered yes in all the groups. This means that farmers give the same answers when they are only asked to give their opinions, but strong differences appear when they are asked about what they are really doing.

In summary there were significant differences among groups with respects to the behaviour of FD-MUs and their propensity to incorporate changes.

7.10. Farmers objectives, personal activities and sources of satisfaction

No significant differences were noted among the groups in relation to farmers objectives over the last three years. It is possible however to order and rank the main answers to explore peculiarities of each FD-MU group (Table 7.11).The categories are: farmers' important personal activities, sources of satisfaction, reasons to continue and happiness with their farming work (Table 7.11). By looking at these categories it is possible to have more elements to better understand the decision making process.

Table 7.11. Farmers' objectives, sources of satisfaction, reasons to farm and income perception, showing χ^2 level of significance.

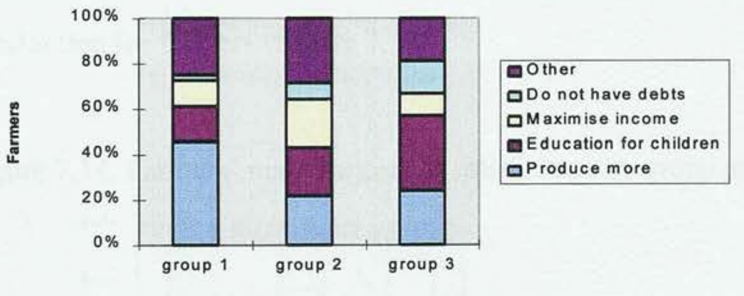
Variables	Significance
Farmers' objectives today	NS
Farmers' objectives three years ago	NS
Farmers' important personal activities	NS
Farmers' main sources of satisfaction	NS
Farmers' main reasons to continue farming	NS
Farmers' satisfaction with their work	NS
Farmers' farm income perception	*

7.11. Main objectives today and three years ago

The main objective in Group1 is increased production, followed by a desire to provide education for children and income maximisation (Figure 7.12). In Group 2, there is a more obvious balance between the objectives: increased production, education for children and income maximisation. In Group 3, the main three objectives are: education for children, increased production and lack of debt (Addendum; Table 6.69).

Results suggest that income maximisation, is not the main objective for any of the FD-MUs analysed. Only in the case of Group 2, does this objective have the same weight as increased production and education for children. Results indicate that FD-MUs objectives are production and family oriented. Education for children appears as the highest priority in Group 3, which bears relation to the fact that this group has the greatest number of young farmers and families.

Figure 7.12. Farmers' objectives today by group and weight.

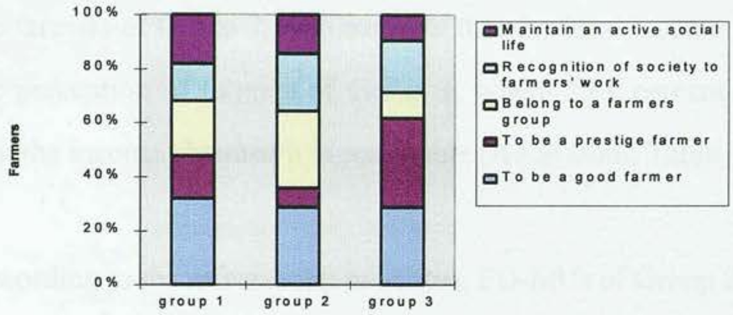


The majority of the farmers have the same objectives now and three years ago, which suggest that farmers do not change their strategic objectives very often (Addendum; Table 7.70).

7.12. Farmers' important personal activities

To be a good farmer and to belong to a farmers' group are the most important activities of FD-MUs in Group 1 and 2. In Group 3, the most important activities are to be a prestige farmer and to be a good farmer (Figure 7.13). Information suggests that FD-MUs in Group 3 are more receptive to social consideration such as prestige.

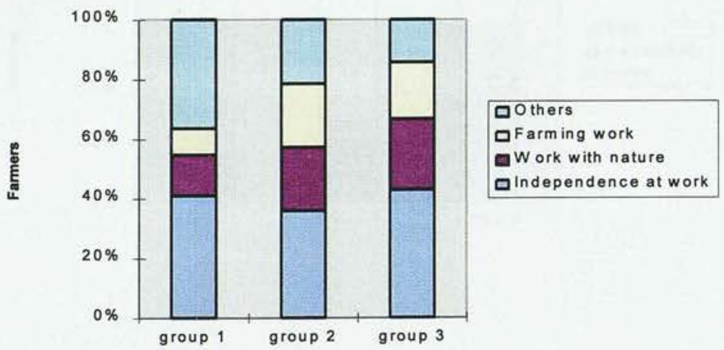
Figure 7.13. Farmers' important personal activities by group and weight.



7.13. Farmers' main sources of satisfaction and happiness with their work

Independence at work and work with nature appear as the main sources of satisfaction for farmers (Figure 7.14).

Figure 7.14. Farmers' main sources of satisfaction by group and weight



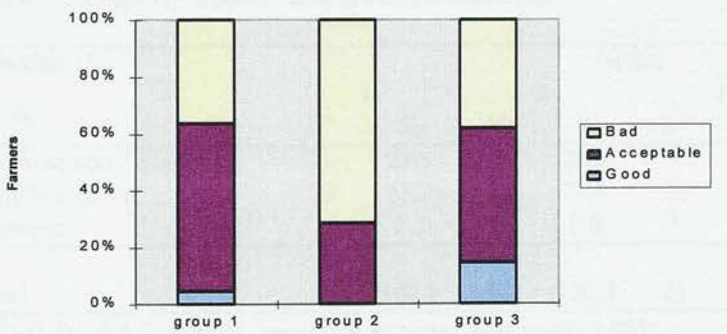
More than 85 percent of the farmers answer that they are happy being a farmer

7.14. Farmers' farm income perception

Significant differences among groups were found only for the farmers' income perception (Table 7.15). The results range between the perception of the majority of the farmers of Group 2, who consider that the farm income is poor (71.4 percent) to the perception of farmers of Group 1, where 59.1 percent of the farmers consider that the income obtained it is acceptable (Addendum; Table 7.74).

According to the information presented, FD-MUs of Group 2 are the most innovative and keen to adopt new technology and to modify and adapt their production system. These FD-MUs are also the more dissatisfied with the income obtained with farm work. Results, confirm what was hypothesised in Chapter 4, that dissatisfaction states are one of the main reasons to explain changes.

Figure 7.15. Farmers, farm income perception.



Addendum Appendix 7.A. (Chapter 7)

Table 7.1 Age of the farmer and group membership

Question 52_edad	Group							
	1		2		3		Total	
Age	N°	%	N°	%	N°	%	N°	%
20-39	9	20.5	2	14.3	9	42.9	20	25.3
40-49	7	15.9	3	21.4	6	28.6	16	20.3
+ 50	28	63.6	9	64.3	6	28.6	43	54.4
Total	44	100.0	14	100.0	21	100.0	79	100.0

(χ^2=8.29, 4 d.f.; P=0.08, minimum expected frequency=2.84)

Table 7.2 Age of the youngest child and group membership

	Group							
	1		2		3		Total	
Age	N°	%	N°	%	N°	%	N°	%
1-9	9	21.3	5	35.7	11	55.0	28	36.9
10-19	7	16.7	3	21.4	3	15.0	13	17.1
20-29	13	31.0	4	28.6	6	30.0	23	30.3
+30	13	31.0	2	14.3	0	0.0	15	19.7
Total	42	100.0	14	100.0	20	100.0	76	100.0

(χ^2= 11.70, 6 d.f. ; P=0.07, minimum expected frequency=2.40)

Table 7.3 Property transfer and group membership

Question 10	Group							
	1		2		3		Total	
	N°	%	N°	%	N°	%	N°	%
Purchase and Tenancy	13	29.5	4	28.6	4	19.0	21	26.6
Family relation	30	68.2	10	71.4	12	57.1	52	65.8
Manager	1	2.3	0	0.0	5	23.8	6	7.6
Total	44	100.0	14	100.0	21	100.0	79	100.0

(χ^2=10.93, 4 d.f.; P=0.03, minimum expected frequency=1.06)

Table 7.4. Farmer formal education and group membership

Question educa_52	Group							
	1		2		3		Total	
	N°	%	N°	%	N°	%	N°	%
Primary Incomplete	10	22.7	1	7.1	1	4.8	12	15.2
P.Complete & Incomplete HS	5	11.4	2	14.3	3	14.3	10	12.7
Complete High-school	11	25.0	2	14.3	5	23.8	18	22.8
Polytech and Others	10	22.7	6	42.9	5	23.8	21	26.6
Complete University	8	18.2	3	21.4	7	33.3	18	22.8
Total	44	100.0	14	100.0	21	100.0	79	100.0

(χ^2=7.57, 8 d.f.; P=0.48, minimum expected frequency=1.77)

Table 7.5. Farmers experience and group membership

	Group							
Question 8	1		2		3		Total	
	N°	%	N°	%	N°	%	N°	%
1 - 9	4	9.01	0	0.0	4	19.0	8	10.1
10 -19	13	29.5	3	21.4	8	38.1	24	30.4
20 - 29	10	22.7	4	28.6	2	9.5	16	20.3
30 - 39	10	22.7	4	28.6	2	9.5	14	17.7
+ 40	7	15.9	3	21.4	5	23.8	15	19.0
Mean	25.4		28.9		21.7			
Total	44	100.0	14	100.0	21	100.0	79	100.0

Table 7.6. Size of the family and group membership

	Group							
	1		2		3		Total	
Number of persons	N°	%	N°	%	N°	%	N°	%
2	4	9.1	1	7.1	1	4.8	6	7.6
3	3	6.8	3	21.4	2	9.5	8	10.1
4	20	45.4	1	7.1	9	42.9	30	38.0
5	9	20.4	5	35.7	5	23.8	19	24.1
6	4	9.1	3	21.4	3	14.3	10	12.7
more than 7	4	9.1	1	7.1	1	4.8	6	7.6
mean		4.6		4.8		4.5		
Total	44	100.0	14	100.0	21	100.0	79	100.0

Table 7.7. Ownership and group membership

Question Number 14	Group							
	1		2		3		Total	
	N°	%	N°	%	N°	%	N°	%
Individual Property	29	65.9	8	57.1	9	42.9	46	58.2
Partnership	15	34.1	6	42.9	12	57.1	33	41.8
Total	44	100.0	14	100.0	21	100.0	79	100.0

(χ^2=3.11, 2 d.f.; *P*=0.21, minimum expected frequency=5.85)

Table 7.8. Farmer residence place and group membership

Question _46_	Group							
	1		2		3		Total	
Recidence place	N°	%	N°	%	N°	%	N°	%
On the farm	6	13.6	0	0.0	3	14.3	9	11.4
On the farm and a city near the farm	8	18.2	5	35.7	2	9.5	15	19.0
On the farm and a city far of the farm	0	0.0	0	0.0	1	4.8	1	1.3
Off the farm	30	63.6	9	57.1	15	71.4	54	68.4
Total	44	100.0	14	100.0	21	100.0	79	100.0

(Too many cells with cero value, not suitable for χ^2 test)

Table 7.9. Family residence place and group membership

Question _46	Group							
	1		2		3		Total	
Recidence place	N°	%	N°	%	N°	%	N°	%
On the farm	3	6.8	0	0.0	2	9.5	5	6.3
On the farm and a city near the farm	0	0.0	3	21.4	1	4.8	4	5.1
On the farm and a city far of the farm	1	2.3	0	0.0	0	0.0	1	1.3
Off the farm	40	90.9	11	78.6	18	85.7	69	87.3
Total	44	100.0	14	100.0	21	100.0	79	100.0

(Too many cells with cero value, not suitable for χ^2 test)

Table 7.10 Farmer's off and on farm activities and group membership

Question 55	Group							
	1		2		3		Total	
Do you have an off-farm activity	N°	%	N°	%	N°	%	N°	%
Yes	20	45.5	3	21.4	9	42.9	32	40.5
Not	24	54.5	11	78.6	12	57.1	47	59.5
Total	44	100.0	14	100.0	21	100.0	79	100.0

(χ^2=2.61, 2 d.f.; P=0.27,minimum expected frequency=5.67)

Table 7.11 Type of off-farm activity and group membership

Question 56	Group							
	1		2		3		Total	
	N°	%	N°	%	N°	%	N°	%
No off-farm activity.	24	54.5	11	78.6	12	57.1	47	59.5
Professional	7	15.9	1	7.1	2	9.5	10	12.7
Merchant	4	9.1	1	7.1	1	4.8	6	7.6
others	9	20.5	1	7.1	6	28.6	16	20.3
Total	44	100.0	14	100.0	21	100.0	79	100.0

(χ^2=4.19, 6 d.f.; P=0.65, minimum expected frequency=1.06).

Table 7.12 Farmer reasons to have an off farm activity and group membership

Question 57	Group							
	1		2		3		Total	
	N°	%	N°	%	N°	%	N°	%
Both works are complementary	6	13.6	2	14.3	5	23.8	13	16.5
Is necessary to afford the expenses	8	18.3	0	0.0	2	9.5	10	12.7
To diversiffy income	6	13.6	1	7.1	2	9.5	9	11.4
No off-farm activity.	24	54.5	11	78.6	12	57.1	47	59.5
Total	44	100.0	14	100.0	21	100.0	79	100.0

(χ^2=5.47, 6 d.f.;P=0.48, minimum expected frequency=1.60).

Table 7.13. Farmers interested on farm diversification and group membership

	Group							
	1		2		3		Total	
Planning changes	N°	%	N°	%	N°	%	N°	%
Yes	12	27.3	11	78.6	14	66.7	37	46.8
No	32	72.7	3	21.4	7	33.3	42	53.2
Total	44	100.0	14	100.0	21	100.0	79	100.0

(χ^2=15.70, 2 d.f.; P=0.00, minimum expected frequency=6.50)

Table 7.14. Planning changes on beef cattle production and group membership

Question 25	Group							
	1		2		3		Total	
Planning changes	N°	%	N°	%	N°	%	N°	%
Yes	12	28.6	4	30.8	11	52.4	27	35.5
No	30	71.4	9	69.2	10	47.6	49	64.5
Total	42	100.0	13	100.0	21	100.0	76	100.0

(χ^2=3.62, 2 d.f.; *P*=0.16, minimum expected frequency=4.62)

Table 7.15. Planning changes on sheep production and group membership

Question _25_1	Group							
	1		2		3		Total	
Planning changes	N°	%	N°	%	N°	%	N°	%
Yes	10	23.3	6	50.0	5	23.8	21	27.6
No	33	76.7	6	50.0	16	76.2	55	72.4
Total	43	100.0	12	100.0	21	100.0	76	100.0

(χ^2=3.57, 2 d.f.; *P*=0.17, minimum expected frequency=3.32)

Table 7.16. Main sources of information and group membership

Question 60	Group							
	1		2		3		Total	
Source of infromation	N°	%	N°	%	N°	%	N°	%
Rural officers and clerks	13	29.5	3	21.4	5	23.8	21	26.6
Family	11	25.0	3	21.4	3	14.3	17	21.5
Advisers	7	15.9	4	28.6	4	19.0	15	19.0
Mass Media	9	20.5	1	7.1	4	19.0	14	17.7
Farm records	3	6.8	2	14.3	2	9.5	7	8.9
Farmers groups or Associations	1	2.3	1	7.1	3	14.3	5	6.3
Total	44	100.0	14	100.0	21	100.0	79	100.0

(χ^2=7.03, 10 d.f.; *P*=0.72, minimum expected frequency=0.89)

Table 7.17. Farmers search field for prices to decide upon a big purchase and group membership

	Group							
	1		2		3		Total	
	N°	%	N°	%	N°	%	N°	%
Purchase in the usual supplier	29	65.9	10	71.4	10	47.6	49	62.0
Look in local suppliers	13	29.5	3	21.4	9	42.9	25	31.6
National suppliers	2	4.5	1	7.1	2	9.5	5	6.3
Total	44	100.0	14	100.0	21	100.0	79	100.0

(χ^2=2.94, 4 d.f.; *P*=0.57, minimum expected frequency=0.89)

Table 7.18. Main reasons to kept records and group membership

Question 69	Group							
	1		2		3		Total	
Reasons	N°	%	N°	%	N°	%	N°	%
Because it is compulsory	25	56.8	4	28.6	4	19.0	33	41.8
I need it to manage the farm	14	31.8	7	50.0	11	52.4	32	40.5
Just to have papers in order	5	11.4	3	21.4	6	28.6	14	17.7
Total	44	100.0	14	100.0	21	100.0	79	100.0

(χ^2=9.93, 4 d.f.; P=0.04, minimum expected frequency=2.48)

Table 7.19. Farmers' main use of farm records and group membership

Question 70	Group							
	1		2		3		Total	
	N°	%	N°	%	N°	%	N°	%
To know the farm situation	10	22.7	5	35.7	7	33.3	22	27.8
To take investment decisions	5	11.4	3	21.4	3	14.3	11	13.9
Other farm activities	12	27.3	1	7.1	10	47.6	23	29.1
Do not use	17	38.6	5	35.7	1	4.8	23	29.1
Total	44	100.0	14	100.0	21	100.0	79	100.0

(χ^2=12.42, 6 d.f.; P=0.05, minimum expected frequency=1.95)

Table 7.20. Farmers' production costs knowledge and group membership

Question 71	Group							
	1		2		3		Total	
Production cost knowledge	N°	%	N°	%	N°	%	N°	%
Yes	6	13.6	6	42.9	10	47.6	22	27.8
No	38	86.4	8	57.1	11	52.4	57	72.2
Total	44	100.0	14	100.0	21	100.0	79	100.0

(χ^2=10.07, 2 d.f.; P=0.01, minimum expected frequency=3.90)

Table 7.21. Farmers' production costs and group membership

Question 71.1	Group							
	1		2		3		Total	
Production cost	N°	%	N°	%	N°	%	N°	%
Do not know	38	86.4	8	37.1	11	52.4	57	72.2
US$ 16-25	3	6.8	0	0.0	4	19.0	7	8.9
US$ 26-35	2	4.5	3	21.4	4	19.0	9	11.4
US$ + 36	1	2.3	3	21.4	2	9.5	6	7.6
Average for answers known cost								
Total	44	100.0	14	100.0	21	100.0	79	100.0

(χ^2=16.11, 6 d.f.; P=0.01, minimum expected frequency=1.06)

Table 7.22. Farmer's key information for support decisons and group membership

Question 72	Group							
	1		2		3		Total	
	N°	%	N°	%	N°	%	N°	%
Market information	25	56.8	5	35.7	5	23.8	35	44.3
Farm records	8	18.2	5	35.7	6	28.6	19	24.1
Farm records and market information	7	15.9	3	21.4	7	33.3	17	21.5
Others	4	9.1	1	7.1	3	14.3	8	10.1
Total	44	100.0	14	100.0	21	100.0	79	100.0

(χ^2=7.91, 6 d.f.; P=0.24, minimum expected frequency=1.42)

Table 7.23. Farmer's type of information for support decisions and group membership

Question 73	Group							
	1		2		3		Total	
Type of infromation	N°	%	N°	%	N°	%	N°	%
Mainly Formal	9	20.5	2	14.3	6	28.6	17	21.5
Formal and Informal	4	9.1	7	50.0	8	38.1	19	24.1
Mainly Informal	31	70.5	5	35.7	7	33.3	43	54.4
Total	44	100.0	14	100.0	21	100.0	79	100.0

(χ^2=15.27, 4 d.f.; P=0.00, minimum expected frequency=3.01)

Table 7.24. Differential use of formal or informal information according to to the type of decision and group membership

	Group							
	1		2		3		Total	
Different use of information	N°	%	N°	%	N°	%	N°	%
Yes	13	29.5	7	50.0	16	76.2	36	45.6
No	31	70.5	7	50.0	5	23.8	43	54.4
Total	44	100.0	14	100.0	21	100.0	79	100.0

(χ^2=12.60, 2 d.f.; P=0.00, minimum expected frequency=6.38)

Table 7.25. Main use of formal information and group membership

Question 75	Group							
	1		2		3		Total	
Use	N°	%	N°	%	N°	%	N°	%
Planning and investments	5	11.4	3	21.4	10	47.6	18	22.8
Credits enquires	6	13.6	3	21.4	2	9.5	11	13.9
Accountability	4	9.1	1	7.1	1	4.8	6	7.6
Production decisions	0	0.0	1	7.1	3	14.3	4	5.1
Do not use formal	29	65.9	6	42.9	5	23.8	40	50.6
Total	44	100.0	14	100.0	21	100.0	79	100.0

(χ^2=20.48, 8 d.f.; P=0.01, minimum expected frequency=0.71)

Table 7.26. Farmers' use of intutition or analysis to support decisions and group membership

Question 76	Group							
	1		2		3		Total	
	N°	%	N°	%	N°	%	N°	%
Mainly Intuition	22	50.0	2	14.3	5	23.8	29	36.7
Intuition and Analysis	16	36.4	10	71.4	12	57.1	38	48.1
Mainly Analysis	6	13.6	2	14.3	4	19.0	12	15.2
Total	44	100.0	14	100.0	21	100.0	79	100.0

(χ^2=8.47, 4 d.f.; P=0.08, minimum expected frequency=2.13)

Table 7.27. Farmer' s decisions that requires more analysis and group membership

Question 77	Group							
	1		2		3		Total	
	N°	%	N°	%	N°	%	N°	%
Investments	17	38.6	6	42.9	10	47.6	33	41.8
Credits	9	20.5	2	14.3	3	14.3	14	17.7
Change commodities	4	9.1	3	21.4	1	4.8	8	10.1
Others	14	31.8	3	21.4	7	33.3	24	30.4
Total	44	100.0	14	100.0	21	100.0	79	100.0

(χ^2=3.57, 6 d.f.; P=0.73, minimum expected frequency=1.42)

Table 7.28. Farmer's decisions that they think they need advise and group membership

Question 78	Group							
	1		2		3		Total	
	N°	%	N°	%	N°	%	N°	%
Production and technical	24	54.5	9	64.3	9	42.9	42	53.2
Economic and financial	17	38.6	3	21.4	9	42.9	29	36.7
Commodity changes	3	6.8	2	14.3	3	14.3	8	10.1
Total	44	100.0	14	100.0	21	100.0	79	100.0

(χ^2=2.98, 4 d.f.; P=0.56, minimum expected frequency=1.42)

Table 7.29. Decision where farmer's think they need to concentrate their effort to have success and group membership

Question 79	Group							
	1		2		3		Total	
	N°	%	N°	%	N°	%	N°	%
Production and technical	31	70.5	9	64.3	13	61.9	53	67.1
Economic and financial	11	25.0	5	35.7	8	38.1	24	30.4
Commodity changes	2	4.5	0	0.0	0	0.0	2	2.5
Total	44	100.0	14	100.0	21	100.0	79	100.0

(Too many cells with cero value, not suitable for χ^2 test)

Table 7.30. Farmers that own a computer and group membership

Question_64	Group							
	1		2		3		Total	
	N°	%	N°	%	N°	%	N°	%
Yes	3	6.8	2	14.3	10	47.6	15	19.0
Not	41	93.2	12	85.7	11	52.4	64	81.0
Total	44	100.0	14	100.0	21	100.0	79	100.0

(χ^2=15.62, 2 d.f.; P=0.00, minimum expected frequency=2.66)

Table 6.31. Farmer's main reasons to do not have a computer and age of the farmer

	Group							
	1		2		3		Total	
Reasons	N°	%	N°	%	N°	%	N°	%
Lack of understanding and no interest	18	40.9	3	21.4	5	23.8	26	32.9
It is not justified	11	25.0	3	21.4	1	4.8	15	19.0
Have other priorities	8	18.2	4	28.6	1	4.8	13	16.5
Considered in the future	1	2.3	1	7.1	2	9.5	4	5.1
The adviser need to have one	3	6.8	1	7.1	2	9.5	6	7.6
Already have a computer	3	6.8	2	14.3	10	47.6	15	19.0
Total	44	100.0	14	100.0	21	100.0	79	100.0

(χ^2=22.56, d.f.=10; P=0.01, minimum expected frequency=0.71)

Table 6.32. Use of computers on farm and age of the farmer

	Group							
	1		2		3		Total	
Computer use	N°	%	N°	%	N°	%	N°	%
Use on the farm	1	2.3	2	14.3	7	33.3	10	12.7
Do not use on the farm	2	4.5	0	0.0	3	14.3	5	6.3
Do not have a computer	41	93.2	12	85.7	11	52.4	64	81.0
Total	44	55.7	14	17.7	21	26.6	79	100.0

(χ^2=17.04, d.f.=4; P=0.00, minimum expected frequency=0.89)

Table 7.33. Acquisition of ideas from other farmers and group membership

Question 82	Group							
	1		2		3		Total	
Answer	N°	%	N°	%	N°	%	N°	%
Yes	31	70.5	14	100	16	76.2	61	77.2
No	13	29.6	0	0.0	5	23.8	18	22.8
Total	44	100.0	14	100.0	21	100.0	79	100.0

(χ^2=5.29, 2 d.f.; P=0.07, minimum expected frequency=3.19)

Table 7.34. Acceptance of your ideas by other farmers and group membership

Question 83	Group							
	1		2		3		Total	
Answer	N°	%	N°	%	N°	%	N°	%
Yes	24	54.5	11	78.6	17	81.0	52	65.8
No	20	45.5	3	21.4	4	19.0	27	34.2
Total	44	100.0	14	100.0	21	100.0	79	100.0

(χ^2=5.63, 2d.f.; P=0.06, minimum expected frequency=4.79)

Table 7.35. Farmers' more useful communication source of farming practicies and group membership

	Group							
	1		2		3		Total	
Answer	N°	%	N°	%	N°	%	N°	%
Ideas exchange with other farmers	17	38.6	5	35.7	6	28.6	28	35.4
Ideas exchenge with advisers	13	29.5	4	28.6	4	19.0	21	26.6
Technical meetings	2	4.5	2	14.3	3	14.3	7.	8.9
Field days	3	6.8	0	0.0	4	19.0	7	8.9
Others	9	20.5	3	21.4	4	19.0	16	20.3
Total	44	100.0	14	100.0	21	100.0	79	100.0

(χ^2=7.04, 8 d.f.; P=0.53, minimum expected frequency=1.24)

Table 7.36. Farm organisation and group membership

Question 91	Group							
	1		2		3		Total	
	N°	%	N°	%	N°	%	N°	%
Mainly family	35	79.5	9	64.3	8	38.1	52	65.8
Family enterprise	7	15.9	2	14.3	5	23.8	14	17.7
Mainly enterprise	2	4.6	3	21.4	8	38.1	13	16.5
Total	44	100.0	14	100.0	21	100.0	79	100.0

(χ^2=14.30, 4 d.f.; P=0.01, minimum expected frequency=2.30)

Table 7.37. Farm organisation farmers' think is better for farming and group membership

Question 92	Group							
	1		2		3		Total	
	N°	%	N°	%	N°	%	N°	%
Mainly family	26	59.0	7	50.0	6	28.6	39	49.3
Family enterprise	9	20.5	3	21.4	4	19.0	16	20.3
Mainly enterprise	9	20.5	4	28.6	11	52.4	24	30.4
Total	44	100.0	14	100.0	21	100.0	79	100.0

(χ^2=7.5, 4 d.f.; P=0.11, minimum expected frequency=2.8)

Table 7.38. Frequency of programming achieves and group membership

Question 94	Group							
	1		2		3		Total	
Programming farm activities	N°	%	N°	%	N°	%	N°	%
Always	3	6.8	3	21.4	4	19.0	10	12.7
Almost always	15	34.1	11	78.6	10	47.6	36	45.6
Almost never	26	59.1	0	0.0	7	33.3	33	41.8
Total	44	100.0	14	100.0	21	100.0	79	100.0

(χ^2=16.72, 4 d.f.; P=0.00, minimum expected frequency=1.77)

Table 7.39. Period of programmming achieves and group membership

Question 95	Group							
	1		2		3		Total	
	N°	%	N°	%	N°	%	N°	%
Not programme	19	43.2	0	0.0	4	19.0	23	29.1
1 to 6 months	13	29.5	3	21.4	9	42.9	25	31.6
one Year or more	12	27.3	11	78.6	8	38.1	31	39.2
Total	44	100.0	14	100.0	21	100.0	79	100.0

(χ^2=16.29, 4 d.f.; P=0.00, minimum expected frequency=4.07)

Table 7.40. Size of the farm and group membership

	Group							
	1		2		3		Total	
Size	N°	%	N°	%	N°	%	N°	%
500-999	24	54.5	5	35.7	2	9.5	31	39.2
1000-2499	13	29.5	6	42.9	4	19.0	23	29.1
+2500	7	15.9	3	21.4	15	71.4	25	31.6
Total	44	100.0	14	100.0	21	100.0	79	100.0

(χ^2=23.45, 4 d.f.; P=0.00, minimum expected frequency=4.07)

Table 7.41. Farm by agroecozone and group membership

	Group							
	1		2		3		Total	
Agroecozone	N°	%	N°	%	N°	%	N°	%
Shallow soils	31	70.4	2	14.3	9	42.9	42	53.2
Deep soils	13	29.6	12	85.7	12	57.1	37	46.8
Total	44	100.0	14	100.0	21	100.0	79	100.0

(χ^2=14.68, 2 d.f.; P=0.00, minimum expected frequency=6.56)

Table 7.42.Farmer preferred working system

Question Number 16	Group							
	1		2		3		Total	
	N°	%	N°	%	N°	%	N°	%
Beef cattle	7	15.9	2	14.3	0	0.0	9	11.4
Sheep	5	11.4	1	7.1	2	9.5	8	10.1
Cattle and sheep together	32	72.7	11	78.6	19	90.5	62	78.5
Total	44	100.0	14	100.0	21	100.0	79	100.0

(χ^2=4.05, 4 d.f.; *P*=0.40, minimum expected frequency=1.42)

Table 7.43. Main activity on beef cattle production and group membership

Question Number 17	Group							
	1		2		3		Total	
	N°	%	N°	%	N°	%	N°	%
Cow-calf	19	43.2	4	28.6	4	19.0	27	34.2
Complete Cycle	13	29.5	7	50.0	10	47.6	30	38.0
Finishing	5	11.4	3	21.4	1	4.8	9	11.4
Other	7	15.9	0	0.0	6	28.6	13	16.5
Total	44	100.0	14	100.0	21	100.0	79	100.0

(χ^2=10.68, 6 d.f.; *P*=0.09, minimum expected frequency=1.60)

Table 7.44. Main activity on sheep production and group membership

Question Number 18	Group							
	1		2		3		Total	
	N°	%	N°	%	N°	%	N°	%
Sheep-lamb breeding	14	33.3	5	38.5	1	4.8	20	26.3
Complete Cycle	28	66.7	8	61.5	20	95.2	56	73.7
Total	42	100.0	13	100.0	21	100.0	76	100.0

(χ^2=7.09, 2 d.f.; *P*=0.03, minimum expected frequency=3.42)

Table7.45. Some production system indicators showing level of significance and group membership

System Indicators	Group 1	2	3	LSD F Ratio	Significance
Size					
Average (hectares)	1310	1663	4692	13.95	**
Total Animal Units					
Average	1024	1305	3274	14.60	**
Stocking Rate/ha					
Sheeps Stocking AU/ha	0.45	0.43	0.40	0.33	NS
Cattle Stocking AU/ha	0.33	0.41	0.36	1.29	NS
Horses Stocking AU/ha	0.03	0.03	0.02	8.37	*
Total Stocking AU/ha	0.81	0.87	0.78	0.73	NS
Cattle Heads					
Average	633	1002	2115	15.38	**
Sheep Heads					
Average	2755	2829	8575	11.0	**
Ratio					
Sheep/Cattle - On-Farm[1]	5.86	4.35	3.90	2.34	**
Weaning Cattle					
Average %	51%	60%	55%	1.2	NS
Weaning Sheep percentage					
Average %	65%	72%	68%	0.57	NS
Improved Pastures					
Average %	1.1	7.8	4.1	13.29	**
Crops Land					
Average %	1.8	7	5	2.23	NS
Wool Production					
Kg/ha	7.41	7.09	6.36	0.51	NS
Non-Family labour					
Permanent labourers/Farm	2.7	4.4	8.6	9.62	**
Days of seasonal labour/ Farm	76	66	290	10.43	**

[1]Obtained by the average of the sheep/cattle ratio in each farm

Table 7.46. Farmers' perception of main seasonal bottle neck for animals and pasture production and group membership

Question 165	Group							
	1		2		3		Total	
Period	N°	%	N°	%	N°	%	N°	%
Summer	13	29.5	1	7.1	5	23.8	19	24.1
Winter	31	70.5	13	92.9	16	76.2	60	75.9
Total	44	100.0	14	100.0	21	100.0	79	100.0

(χ^2=2.92, 2 d.f.; P=0.23, minimum expected frequency=3.37)

Table 7.47. Farmers' strategy to cope with the identified seasonal bottle neck for animals and pastures and group membership

Question 166	Group							
	1		2		3		Total	
	N°	%	N°	%	N°	%	N°	%
Pasture improvments	3	6.8	9	64.3	9	42.9	21	26.6
Agist	10	22.7	0	0.0	3	14.3	13	16.5
To sell animals	7	15.9	0	0.0	5	23.8	12	15.2
Forage crops	1	2.3	3	21.4	2	9.5	6	7.6
Others	5	11.4	1	7.1	1	4.8	7	8.9
To do nothing	18	40.9	1	7.1	1	4.8	20	25.3
Total	44	100.0	14	100.0	21	100.0	79	100.0

(χ^2=38.21, 10 d.f.; P=0.00, minimum expected frequency=1.01)

Table 7.48. Farmers' considering to include a new practice for animal feeding in the future and group membership

Question 176	Group							
	1		2		3		Total	
	N°	%	N°	%	N°	%	N°	%
Yes	25	56.8	13	92.9	17	81.0	55	69.6
No	17	38.6	1	7.1	3	14.3	21	26.6
I do not know	2	4.5	0	0.0	1	4.8	3	3.8
Total	44	100.0	14	100.0	21	100.0	79	100.0

(χ^2=8.75, 4 d.f.; P=0.07, minimum expected frequency=0.53)

Table 7.49. Number and size of paddocks and group membership

Equipos Question 23	Group							
	1		2		3		Total	
Number of paddocks	N°	%	N°	%	N°	%	N°	%
1-3	11	25.0	2	14.3	1	4.8	14	17.7
4-6	21	47.7	4	28.6	3	14.3	28	35.5
7-9	7	15.9	3	21.4	1	4.8	11	13.9
+10	5	11.4	5	35.7	16	76.1	26	32.9
Mean per farm		5.7		9.9		16.4		
Total	44	100.0	14	100.0	21	100.0	79	100.0

Table 7.50. Use of electric fence and group membership

Question 104 Equipos	Group							
	1		2		3		Total	
	N°	%	N°	%	N°	%	N°	%
Yes	6	13.6	8	57.1	6	28.6	20	25.3
No	38	86.4	6	42.9	15	71.4	59	74.7
Total	44	100.0	14	100.0	21	100.0	79	100.0

(χ^2=10.79, 2 d.f.; P=0.00, minimum expected frequency=3.54)

Table 7.51. Winter supplementation with grain and group membership

Question 107 Equipos	Group							
	1		2		3		Total	
	N°	%	N°	%	N°	%	N°	%
Yes	0	0.0	2	14.4	2	9.5	4	5.1
No	28	63.6	6	42.8	8	38.1	42	53.2
Only during the drought	16	36.4	6	42.8	11	52.4	33	41.7
Total	44	100.0	14	100.0	21	100.0	79	100.0

(χ^2=8.37, 4 d.f.; P=0.08, minimum expected frequency=0.79)

Table 7.52. Farmers' use of best pasture to animals finishing and group membership

Question 177	Group							
	1		2		3		Total	
	N°	%	N°	%	N°	%	N°	%
Yes	28	63.6	9	64.3	19	90.5	56	70.9
No	16	36.4	5	35.7	2	9.5	23	29.1
Total	44	100.0	14	100.0	21	100.0	79	100.0

(χ^2=5.32, 2 d.f.; P=0.07, minimum expected frequency=4.08)

Table 7.53. Farmers' main objective with pastures and group membership

Question 163	Group							
	1		2		3		Total	
Objective	N°	%	N°	%	N°	%	N°	%
Feed animals	17	38.6	10	71.4	14	66.7	41	51.9
To Maintain natural grasslands	13	29.5	0	0.0	2	9.5	15	19.0
Improve the soil	4	9.1	1	7.1	4	19.0	9	11.4
Others	10	22.7	3	21.4	1	4.8	14	17.7
Total	44	100.0	14	100.0	21	100.0	79	100.0

(χ^2=13.86, 6 d.f.; P=0.03, minimum expected frequency=1.59)

Table 7.54. Farmers' base rule for quality pasture determination and group membership

Question 164	Group							
	1		2		3		Total	
Rule based on	N°	%	N°	%	N°	%	N°	%
Animals weight increase	20	47.6	6	42.9	13	65.0	39	51.3
Legumes availability	5	11.9	4	28.6	3	15.0	12	15.8
Pasture availability	6	14.3	2	14.3	2	10.0	10	13.2
Others	13	29.5	2	14.3	3	14.3	18	22.8
Total	44	100.0	14	100.0	21	100.0	79	100.0

(χ^2=5.23, 6 d.f.; P=0.51, minimum expected frequency=1.77)

Table 7.55. Farmers' rule for pasture management control and group membership

	Group							
	1		2		3		Total	
	N°	%	N°	%	N°	%	N°	%
Pasture height	29	65.9	7	50.0	11	52.4	47	59.5
Availability of green pasture	9	20.5	4	28.6	7	33.3	20	25.3
Pasture colour	4	9.1	1	7.1	0	0.0	5	6.3
Others	2	4.5	2	14.3	3	14.3	7	8.9
Total	44	100.0	14	100.0	21	100.0	79	100.0

(χ^2=5.66, 6 d.f.; P=0.46, minimum expected frequency=0.89)

Table 7.56. Farmers rule base for animals management control and group membership

Question 182	Group							
	1		2		3		Total	
Rule based on:	N°	%	N°	%	N°	%	N°	%
Score condition	41	93.2	11	78.6	19	90.5	71	89.8
Scale	1	2.3	1	7.1	2	9.5	4	5.1
Other	2	4.5	2	14.3	0	0.0	4	5.1
Total	44	100.0	14	100.0	21	100.0	79	100.0

(χ^2=5.31, 4 d.f.; P=0.25, minimum expected frequency=0.71)

Table 7.57. Frequency of counting the animals and group membership

Equipos-Question 29	Group							
	1		2		3		Total	
	N°	%	N°	%	N°	%	N°	%
Every month	23	52.3	11	78.6	9	42.9	43	54.4
Every two month	4	9.1	3	21.4	5	23.8	12	15.2
more than two month	17	38.6	0	0.0	7	33.3	24	30.4
Total	44	100.0	14	100.0	21	100.0	79	100.0

(χ^2=9.82, 4 d.f.; P=0.04, minimum expected frequency=2.13)

Table 7.58. Use of credit and group membership

Equipos - Question 39	Group							
	1		2		3		Total	
Use of credit	N°	%	N°	%	N°	%	N°	%
Yes	16	36.4	8	57.1	4	19.0	28	35.4
Not	28	63.6	6	42.9	17	81.0	51	64.6
Total	44	100.0	14	100.0	21	100.0	79	100.0

(χ^2=5.36, 2 d.f.; P=0.07, minimum expected frequency=4.96)

Table 7.59. Labour as a constraint to adopt technology

Question 99	Group							
	1		2		3		Total	
	N°	%	N°	%	N°	%	N°	%
Yes	25	56.8	12	85.7	14	66.7	51	64.6
No	19	43.2	2	14.3	7	33.3	28	35.4
Total	44	100.0	14	100.0	21	100.0	79	100.0

(χ^2=3.93, 2 d.f.; P=0.14, minimum expected frequency=4.96)

Table 7.60. Use of advice

Question Number 30	Group							
	1		2		3		Total	
	N°	%	N°	%	N°	%	N°	%
Yes	13	29.5	8	57.1	10	47.6	31	39.2
Not	31	70.5	6	42.9	11	52.4	48	60.8
Total	44	100.0	14	100.0	21	100.0	79	100.0

(χ^2=4.23, 2 d.f.; P=0.12, minimum expected frequency=5.50)

Table 7.61. Use of agronomic advice and group membership

Equipos Question 60	Group							
	1		2		3		Total	
	N°	%	N°	%	N°	%	N°	%
Yes	4	9.1	8	57.1	9	42.9	21	26.6
One of the owner is Agronomist	4	9.1	2	14.3	3	14.2	9	11.4
No	36	81.8	4	28.6	9	42.9	49	62.0
Total	44	100.0	14	100.0	21	100.0	79	100.0

(χ^2=19.10, 4 d.f.; P=0.00, minimum expected frequency=1.60)

Table 7.62. Use of veterinary advise and group membership

Equipos Question 65	Group							
	1		2		3		Total	
	N°	%	N°	%	N°	%	N°	%
Never	4	9.1	0	0.0	2	9.5	6	7.6
1-5	17	38.6	7	50.0	5	23.8	29	36.7
6-10	8	18.2	2	14.3	5	23.8	15	19.0
More than 20	8	18.2	4	28.6	5	23.8	17	21.5
Not very often	7	15.9	1	7.1	4	19.1	12	15.2
Total	44	100.0	14	100.0	21	100.0	79	100.0

(χ^2=4.80, 8 d.f.; P=0.77, minimum expected frequency=1.06)

Table 7.63. Perception of competitivness and new technology and group membership

Question 89	Group							
	1		2		3		Total	
	N°	%	N°	%	N°	%	N°	%
Yes	40	90.9	13	92.8	19	90.5	72	91.1
No	4	9.1	1	7.2	2	9.5	7	8.9
Total	44	100.0	14	100.0	21	100.0	79	100.0

(χ^2=.06, 2 d.f.; P=0.97, minimum expected frequency=1.20)

Table 7.64. Interest in the lastest technology and group membership

Question Number 44	Group							
T	1		2		3		Total	
	N°	%	N°	%	N°	%	N°	%
Yes	6	13.6	11	78.6	9	42.9	26	32.9
No	38	86.4	3	21.4	12	57.1	53	67.1
Total	44	100.0	14	100.0	21	100.0	79	100.0

(χ^2=21.60, 2 d.f.; P=0.00, minimum expected frequency=4.60)

Table 7.65. Farm improvment in recent years and group membership

Question 86	Group							
	1		2		3		Total	
	N°	%	N°	%	N°	%	N°	%
Yes	18	40.9	13	92.9	15	71.4	46	58.2
No	26	59.1	1	7.1	6	28.6	33	41.8
Total	44	100.0	14	100.0	21	100.0	79	100.0

(χ^2=13.83, 2 d.f.; P=0.01, minimum expected frequency=5.85).

Table 7.66. Use of public extension services (Plan Agropecuario) and group membership

Equipos - Question 68	Group							
	1		2		3		Total	
	N°	%	N°	%	N°	%	N°	%
Yes	13	29.5	9	64.3	4	19.0	26	32.9
No	31	70.5	5	35.7	17	81.0	53	67.1
Total	44	100.0	14	100.0	21	100.0	79	100.0

(χ^2=8.30, 2 d.f.; P=0.02, minimum expected frequency=4.61)

Table 7.67. Farmers that had visting a research institution and group membership

Equipos - Question 74	Group							
	1		2		3		Total	
	N°	%	N°	%	N°	%	N°	%
No	37	84.1	5	35.7	13	61.9	55	69.6
INIA	5	11.4	5	35.7	2	9.5	12	15.2
Others	2	4.5	4	28.6	6	28.6	12	15.2
Total	44	100.0	14	100.0	21	100.0	79	100.0

(χ^2=15.97, 4 d.f.; P=0.00, minimum expected frequency=2.13)

Table 7.68. Main branches of INIA visited and group membership

	Group							
	1		2		3		Total	
	N°	%	N°	%	N°	%	N°	%
INIA-Estanzuela	2	4.6	3	21.4	1	4.7	6	7.6
INIA-Tbo	3	6.8	2	14.3	1	4.7	6	7.6
Total	5	11.4	5	35.7	2	9.4	12	15.2

Table 7.69. Farmers' objectives today and group membership

Question 158	Group							
	1		2		3		Total	
	N°	%	N°	%	N°	%	N°	%
Produce more	20	45.5	3	21.4	5	23.8	28	35.4
Give education to children	7	15.9	3	21.4	7	33.3	17	21.5
Maximise income	5	11.4	3	21.4	2	9.5	10	12.7
Do not have debts	1	2.3	1	7.1	3	14.3	5	6.3
Other	11	25.0	4	28.6	4	19.0	19	24.1
Total	44	100.0	14	100.0	21	100.0	79	100.0

(χ^2=9.50, 8 d.f.; P=0.30, minimum expected frequency=0.89)

Table7.70. Farmer objective three years ago and group membership

Question 159	Group							
	1		2		3		Total	
	N°	%	N°	%	N°	%	N°	%
Produce more	6	13.6	1	7.1	0	0.0	7	8.9
Maximise income	2	4.5	1	7.1	2	9.5	5	6.3
Give education to children	2	4.5	1	7.1	1	4.8	4	5.1
Other	6	13.6	3	21.4	2	9.5	11	13.9
Do not change	28	63.6	8	57.1	16	76.2	52	65.8
Total	44	100.0	14	100.0	21	100.0	79	100.0

(χ^2=5.16, 8 d.f.; P=0.74, minimum expected frequency=0.71)

Table 7.71. Farmers' important personal achieves and group membership

Question 161	Group							
	1		2		3		Total	
	N°	%	N°	%	N°	%	N°	%
To be a good farmer	14	31.8	4	28.6	6	28.6	24	30.4
To be a prestige farmer	7	15.9	1	7.1	7	33.3	15	19.0
Belong to farmers group	9	20.5	4	28.6	2	9.5	15	19.0
Recognition of society to farmer work	6	13.6	3	21.4	4	19.0	13	16.5
Maintain an active social life	8	18.2	2	14.3	2	9.5	12	15.2
Total	44	100.0	14	100.0	21	100.0	79	100.0

(χ^2=6.54, 8 d.f.; P=0.58, minimum expected frequency=2.13)

Table 7.72. Farmers' main sources of satisfaction

Question 162	Group							
	1		2		3		Total	
	N°	%	N°	%	N°	%	N°	%
Independence at work	18	40.9	5	35.7	9	42.9	32	40.5
Work with nature	6	13.6	3	21.4	5	23.8	14	17.7
Farming work	4	9.1	3	21.4	4	19.0	11	13.9
Others	16	36.4	3	21.4	3	14.3	22	27.8
Total	44	100.0	14	100.0	21	100.0	79	100.0

(χ^2=5.51, 6 d.f.; P=0.48, minimum expected frequency=1.95)

Table 7.73. Farmers' satisfaction with their work and group membership

Question 39	Group							
	1		2		3		Total	
Are you happy to be a farmer	N°	%	N°	%	N°	%	N°	%
Yes	39	88.6	12	85.7	19	90.5	70	88.6
No	5	11.4	2	14.3	2	9.5	9	11.4
Total	44	100.0	14	100.0	21	100.0	79	100.0

(χ^2=0.19, 2 d.f.; P=0.91, minimum expected frequency=1.60)

Table 7.74. Farmers' farm income perception and group membership

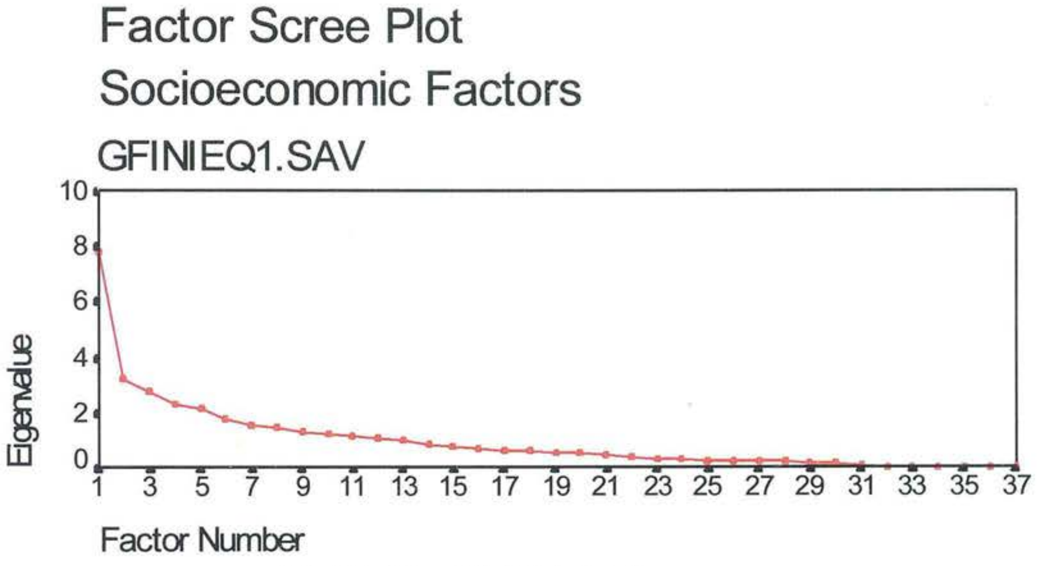
Question 42	Group							
	1		2		3		Total	
The farm income is:	N°	%	N°	%	N°	%	N°	%
Good	2	4.5	0	0.0	3	14.3	5	6.3
Acceptable	26	59.1	4	28.6	10	47.6	40	50.6
Bad	16	36.4	10	71.4	8	38.1	34	43.0
Total	44	100.0	14	100.0	21	100.0	79	100.0

(χ^2=8.41, 4 d.f.; *P*=0.08, minimum expected frequency=0.89)

Appendix 7.B.

Summary of Factor Analysis results.

7. 1. Socioeconomic factors.



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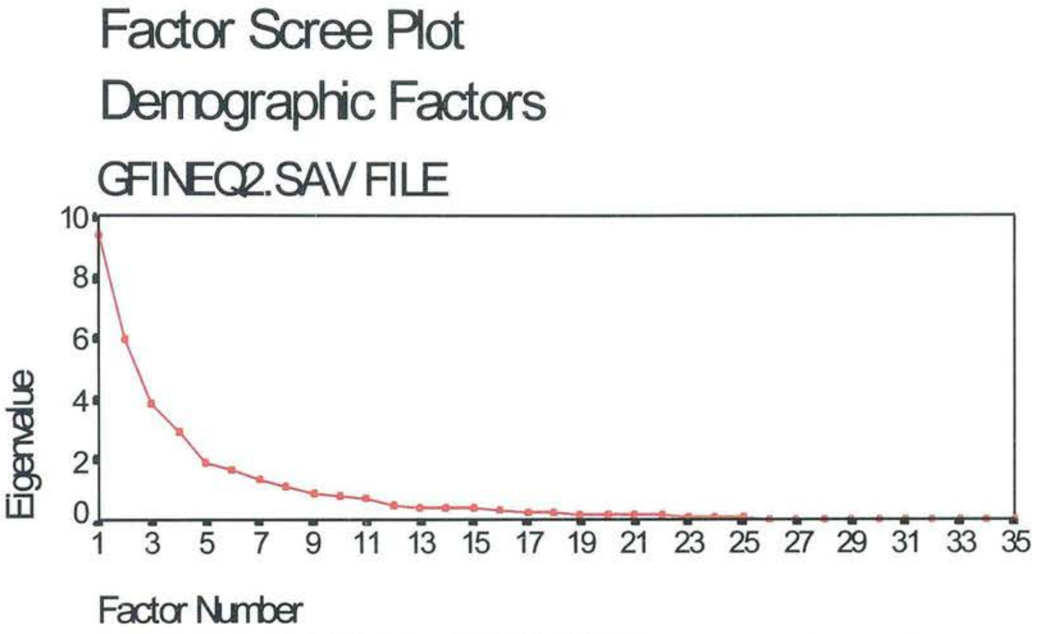
Extraction 1 for analysis 1, Principal Components Analysis (PC)
Initial Statistics:

Variable	Communality	*	Factor	Eigenvalue	Pct of Var	Cum Pct
		*				
AREA_CUL	1.00000	*	1	7.84052	21.2	21.2
AREA_MEJ	1.00000	*	2	3.24498	8.8	30.0
P15_1	1.00000	*	3	2.74881	7.4	37.4
P15_2	1.00000	*	4	2.34369	6.3	43.7
P15_5	1.00000	*	5	2.13997	5.8	49.5
COSTOS	1.00000	*	6	1.81203	4.9	54.4
PESO_231	1.00000	*	7	1.54427	4.2	58.6
PESO_232	1.00000	*	8	1.48152	4.0	62.6
PREG_14	1.00000	*	9	1.32768	3.6	66.2
PREG_16	1.00000	*	10	1.22216	3.3	69.5
PREG_17	1.00000	*	11	1.17193	3.2	72.6
PREG_18	1.00000	*	12	1.08904	2.9	75.6
PREG_19	1.00000	*	13	1.01336	2.7	78.3
PREG_20	1.00000	*	14	.86508	2.3	80.7
PREG_21	1.00000	*	15	.83834	2.3	82.9
PREG_45_	1.00000	*	16	.74774	2.0	84.9
PREG_454	1.00000	*	17	.66336	1.8	86.7
PREG_455	1.00000	*	18	.62687	1.7	88.4
PREG_458	1.00000	*	19	.58159	1.6	90.0
RAZON_21	1.00000	*	20	.53708	1.5	91.5
RAZON_22	1.00000	*	21	.46937	1.3	92.7
RAZON_23	1.00000	*	22	.40629	1.1	93.8
RAZON_24	1.00000	*	23	.36286	1.0	94.8
PESO_23_	1.00000	*	24	.32220	.9	95.7
PREG_28_	1.00000	*	25	.29189	.8	96.5
PREG_281	1.00000	*	26	.26645	.7	97.2
PREG_282	1.00000	*	27	.25383	.7	97.9
PREG_29_	1.00000	*	28	.23512	.6	98.5
PESO_37_	1.00000	*	29	.19827	.5	99.0
PESO_372	1.00000	*	30	.15473	.4	99.5
PREG_382	1.00000	*	31	.10928	.3	99.8
PREG_38_	1.00000	*	32	.04383	.1	99.9

PREG_42	1.00000	*	33	.02663	.1	99.9
PREG_13	1.00000	*	34	.01136	.0	100.0
PREG_31	1.00000	*	35	.00465	.0	100.0
PREG_33	1.00000	*	36	.00281	.0	100.0
PREG_30	1.00000	*	37	.00044	.0	100.0

7.2. Demographic factors.



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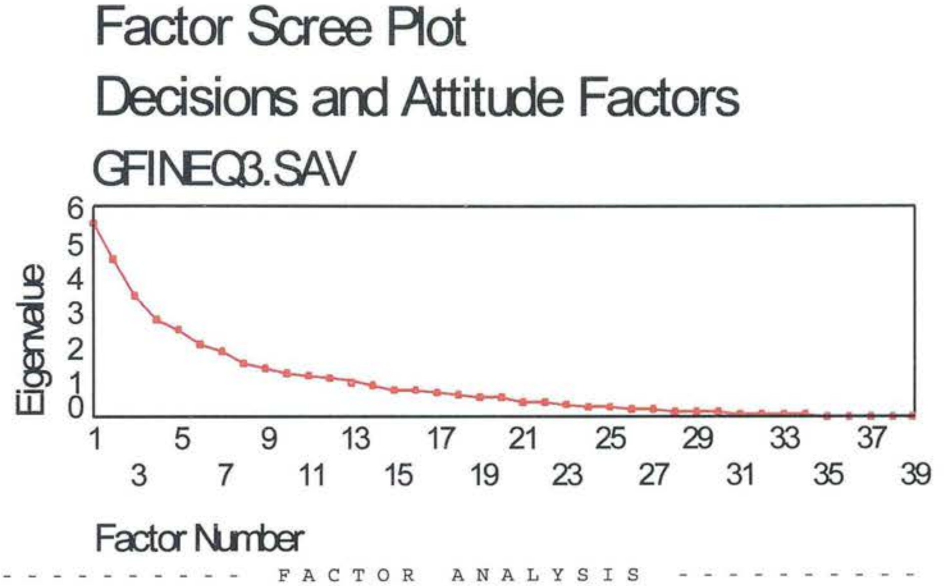
Extraction 1 for analysis 1, Principal Components Analysis (PC)

Initial Statistics:

Variable	Communality	*	Factor	Eigenvalue	Pct of Var	Cum Pct
		*				
CIVIL_51	1.00000	*	1	9.79695	28.0	28.0
CIVIL_52	1.00000	*	2	6.51648	18.6	46.6
CIVIL_53	1.00000	*	3	4.94874	14.1	60.7
CIVIL_54	1.00000	*	4	2.61954	7.5	68.2
CIVIL_55	1.00000	*	5	1.54674	4.4	72.7
CIVIL_56	1.00000	*	6	1.44049	4.1	76.8
EDAD_521	1.00000	*	7	1.30429	3.7	80.5
EDAD_522	1.00000	*	8	1.09151	3.1	83.6
EDAD_523	1.00000	*	9	.90706	2.6	86.2
EDAD_524	1.00000	*	10	.72013	2.1	88.3
EDAD_525	1.00000	*	11	.61738	1.8	90.0
EDAD_52_	1.00000	*	12	.52807	1.5	91.5
EDADMEN	1.00000	*	13	.44960	1.3	92.8
EDUCA_51	1.00000	*	14	.34100	1.0	93.8
EDUCA_52	1.00000	*	15	.32130	.9	94.7
EDUCA_53	1.00000	*	16	.27933	.8	95.5
EDUCA_54	1.00000	*	17	.25740	.7	96.2
EDUCA_55	1.00000	*	18	.20375	.6	96.8
EDUCA_56	1.00000	*	19	.19375	.6	97.4
SEXO_521	1.00000	*	20	.15221	.4	97.8
SEXO_522	1.00000	*	21	.14064	.4	98.2
SEXO_523	1.00000	*	22	.11982	.3	98.6
SEXO_524	1.00000	*	23	.09349	.3	98.8
SEXO_525	1.00000	*	24	.08013	.2	99.1
SEXO_52_	1.00000	*	25	.07374	.2	99.3
TOTCORRE	1.00000	*	26	.05199	.1	99.4
TOTHIJOS	1.00000	*	27	.04576	.1	99.5

VIVE_521	1.00000	*	28	.04096	.1	99.7
VIVE_522	1.00000	*	29	.03079	.1	99.8
VIVE_523	1.00000	*	30	.02353	.1	99.8
VIVE_524	1.00000	*	31	.02248	.1	99.9
VIVE_525	1.00000	*	32	.01553	.0	99.9
VIVE_52_	1.00000	*	33	.00924	.0	100.0
PREG_8	1.00000	*	34	.00875	.0	100.0
PREG_9	1.00000	*	35	.00738	.0	100.0

7.3. Decisions and attitude factors



- - - - - - - - - - - FACTOR ANALYSIS - - - - - - - - - -

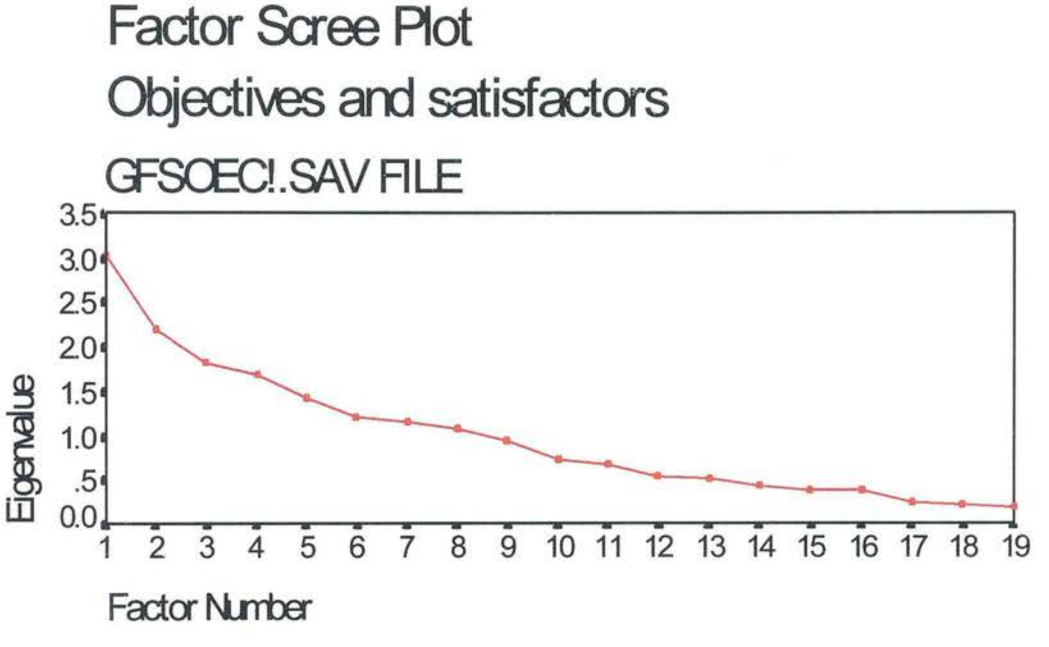
Extraction 1 for analysis 1, Principal Components Analysis (PC)

Initial Statistics:

Variable	Communality	*	Factor	Eigenvalue	Pct of Var	Cum Pct
		*				
P80_COM1	1.00000	*	1	5.53643	14.2	14.2
P80_COMP	1.00000	*	2	4.54507	11.7	25.9
P80_INV1	1.00000	*	3	3.48009	8.9	34.8
P80_INV2	1.00000	*	4	2.80644	7.2	42.0
P80_INVE	1.00000	*	5	2.53434	6.5	48.5
P80_MAN1	1.00000	*	6	2.12366	5.4	53.9
P80_MAN2	1.00000	*	7	1.87249	4.8	58.7
P80_MANE	1.00000	*	8	1.54792	4.0	62.7
P80_VTA	1.00000	*	9	1.39899	3.6	66.3
P80_VTA2	1.00000	*	10	1.24294	3.2	69.5
P80CODIG	1.00000	*	11	1.20247	3.1	72.5
P80_CODI	1.00000	*	12	1.17103	3.0	75.5
P81CODIG	1.00000	*	13	1.03439	2.7	78.2
PESO_81_	1.00000	*	14	.94757	2.4	80.6
P81CODI1	1.00000	*	15	.82126	2.1	82.7
PESO_811	1.00000	*	16	.77594	2.0	84.7
PREG_101	1.00000	*	17	.70943	1.8	86.5
PREG_102	1.00000	*	18	.62658	1.6	88.1
PREG_106	1.00000	*	19	.58413	1.5	89.6
PREG_107	1.00000	*	20	.55680	1.4	91.1
PREG_108	1.00000	*	21	.46337	1.2	92.3
PREG_841	1.00000	*	22	.44901	1.2	93.4
PREG_842	1.00000	*	23	.38234	1.0	94.4
PREG_84_	1.00000	*	24	.32257	.8	95.2
PREG_87	1.00000	*	25	.30142	.8	96.0
PREG_90	1.00000	*	26	.26223	.7	96.7
PREG_91	1.00000	*	27	.23525	.6	97.3

PREG_92	1.00000	*	28	.19347	.5	97.8
PREG_94	1.00000	*	29	.18879	.5	98.2
PREG_95	1.00000	*	30	.15664	.4	98.6
PREG_961	1.00000	*	31	.13049	.3	99.0
PREG_962	1.00000	*	32	.10415	.3	99.3
PREG_96_	1.00000	*	33	.09469	.2	99.5
PREG_97	1.00000	*	34	.08358	.2	99.7
PREG_98	1.00000	*	35	.05094	.1	99.8
PREG_981	1.00000	*	36	.03272	.1	99.9
PREG_98_	1.00000	*	37	.01451	.0	100.0
PREG_85	1.00000	*	38	.00888	.0	100.0
PREG_88	1.00000	*	39	.00697	.0	100.0

7.4. Objectives and satisfactors factors



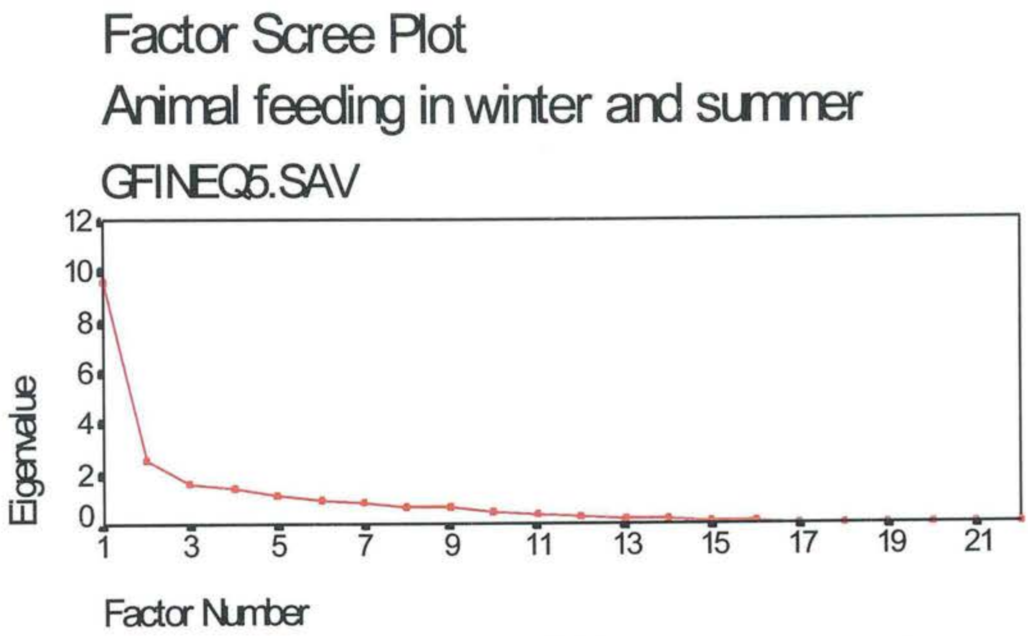
- - - - - - - - - - - FACTOR ANALYSIS - - - - - - - - - - - -

Extraction 1 for analysis 1, Principal Components Analysis (PC)

Initial Statistics:

Variable	Communality	*	Factor	Eigenvalue	Pct of Var	Cum Pct
		*				
PREG1581	1.00000	*	1	3.03734	16.0	16.0
PREG1582	1.00000	*	2	2.20710	11.6	27.6
PREG158_	1.00000	*	3	1.83129	9.6	37.2
PREG1591	1.00000	*	4	1.70847	9.0	46.2
PREG1592	1.00000	*	5	1.41612	7.5	53.7
PREG159_	1.00000	*	6	1.21039	6.4	60.1
PREG1611	1.00000	*	7	1.15471	6.1	66.1
PREG1612	1.00000	*	8	1.09139	5.7	71.9
PREG161_	1.00000	*	9	.94332	5.0	76.8
PREG1621	1.00000	*	10	.74680	3.9	80.8
PREG1622	1.00000	*	11	.67860	3.6	84.3
PREG162_	1.00000	*	12	.55312	2.9	87.3
PREG1631	1.00000	*	13	.51597	2.7	90.0
PREG163_	1.00000	*	14	.44903	2.4	92.3
PREG1661	1.00000	*	15	.39343	2.1	94.4
PREG1662	1.00000	*	16	.37921	2.0	96.4
PREG166_	1.00000	*	17	.25708	1.4	97.8
PREG_169	1.00000	*	18	.23680	1.2	99.0
PREG_174	1.00000	*	19	.18983	1.0	100.0

7.5. Animal feeding in winter and summer factors

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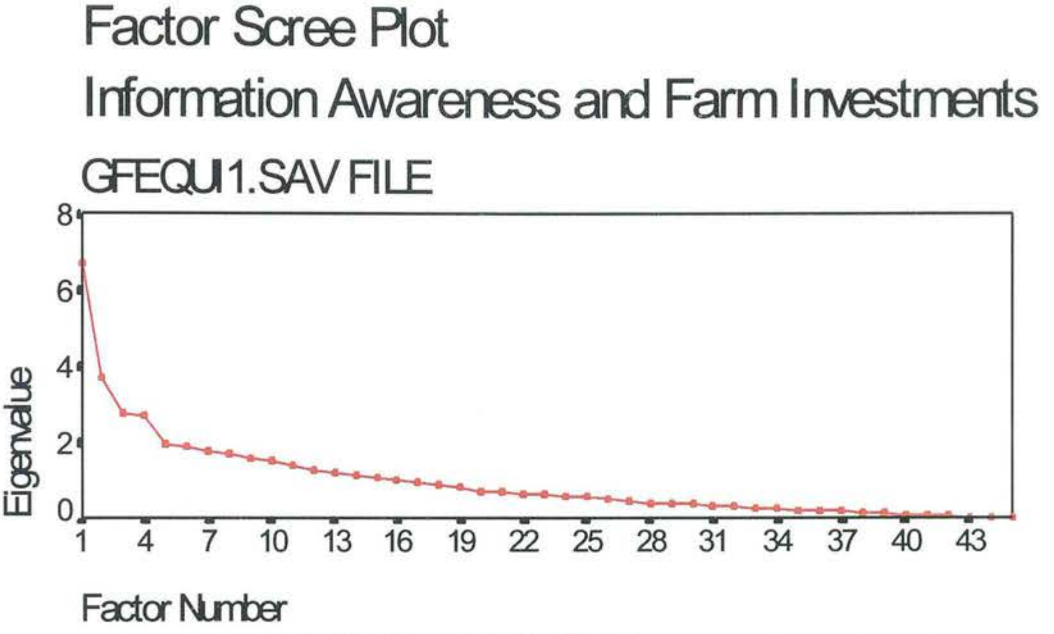
Extraction    1 for analysis    1, Principal Components Analysis (PC)

Initial Statistics:
```

Variable	Communality	*	Factor	Eigenvalue	Pct of Var	Cum Pct
		*				
P181_10I	1.00000	*	1	9.64638	43.8	43.8
P181_1IN	1.00000	*	2	2.60267	11.8	55.7
P181_2IN	1.00000	*	3	1.67167	7.6	63.3
P181_3IN	1.00000	*	4	1.41038	6.4	69.7
P181_4IN	1.00000	*	5	1.15009	5.2	74.9
P181_6IN	1.00000	*	6	1.00571	4.6	79.5
P181_7IN	1.00000	*	7	.89482	4.1	83.6
P181_8IN	1.00000	*	8	.74276	3.4	86.9
P181_9IN	1.00000	*	9	.66027	3.0	89.9
P181_1VE	1.00000	*	10	.54125	2.5	92.4
P181_2VE	1.00000	*	11	.44541	2.0	94.4
P181_3VE	1.00000	*	12	.28325	1.3	95.7
P181_4VE	1.00000	*	13	.24027	1.1	96.8
P181_5VE	1.00000	*	14	.21750	1.0	97.8
P181_6VE	1.00000	*	15	.14028	.6	98.4
P181_7VE	1.00000	*	16	.10527	.5	98.9
P118_5IN	1.00000	*	17	.08908	.4	99.3
PREG_179	1.00000	*	18	.05748	.3	99.6
PREG_180	1.00000	*	19	.03292	.1	99.7
PREG_182	1.00000	*	20	.03003	.1	99.9
PREG_183	1.00000	*	21	.02246	.1	100.0
PREG_184	1.00000	*	22	.01004	.0	100.0

7.6. Information awareness and farm investments factors



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Extraction 1 for analysis 1, Principal Components Analysis (PC)

Initial Statistics:

Variable	Communality	*	Factor	Eigenvalue	Pct of Var	Cum Pct
		*				
PRE1_40	1.00000	*	1	6.80116	14.8	14.8
PRE1_43	1.00000	*	2	3.72806	8.1	22.9
PRE1_43A	1.00000	*	3	2.79836	6.1	29.0
PRE1_43B	1.00000	*	4	2.70175	5.9	34.8
PRE1_43C	1.00000	*	5	2.01947	4.4	39.2
PRE1_43D	1.00000	*	6	1.98965	4.3	43.6
PRE1_43E	1.00000	*	7	1.81612	3.9	47.5
PRE1_43F	1.00000	*	8	1.73643	3.8	51.3
PRE1_43G	1.00000	*	9	1.58667	3.4	54.7
PRE1_43H	1.00000	*	10	1.51681	3.3	58.0
PRE1_43I	1.00000	*	11	1.42524	3.1	61.1
PRE1_43K	1.00000	*	12	1.28206	2.8	63.9
PRE1_43L	1.00000	*	13	1.23615	2.7	66.6
PRE1_44	1.00000	*	14	1.17432	2.6	69.2
PRE1_46	1.00000	*	15	1.14691	2.5	71.7
PRE1_46A	1.00000	*	16	1.07313	2.3	74.0
PRE1_46B	1.00000	*	17	1.00487	2.2	76.2
PRE1_46C	1.00000	*	18	.92701	2.0	78.2
PRE1_47	1.00000	*	19	.85030	1.8	80.0
PRE1_48	1.00000	*	20	.78398	1.7	81.7
PRE1_49	1.00000	*	21	.71419	1.6	83.3
PRE1_50	1.00000	*	22	.66845	1.5	84.7
PRE1_51	1.00000	*	23	.65127	1.4	86.2
PRE1_52	1.00000	*	24	.62338	1.4	87.5
PRE1_52A	1.00000	*	25	.59484	1.3	88.8
PRE1_52B	1.00000	*	26	.56479	1.2	90.0
PRE1_52C	1.00000	*	27	.52723	1.1	91.2
PRE1_52D	1.00000	*	28	.46937	1.0	92.2
PRE1_52E	1.00000	*	29	.42064	.9	93.1
PRE1_52F	1.00000	*	30	.39986	.9	94.0
PRE1_52G	1.00000	*	31	.37223	.8	94.8
PRE1_56	1.00000	*	32	.34362	.7	95.5
PRE1_57	1.00000	*	33	.30965	.7	96.2

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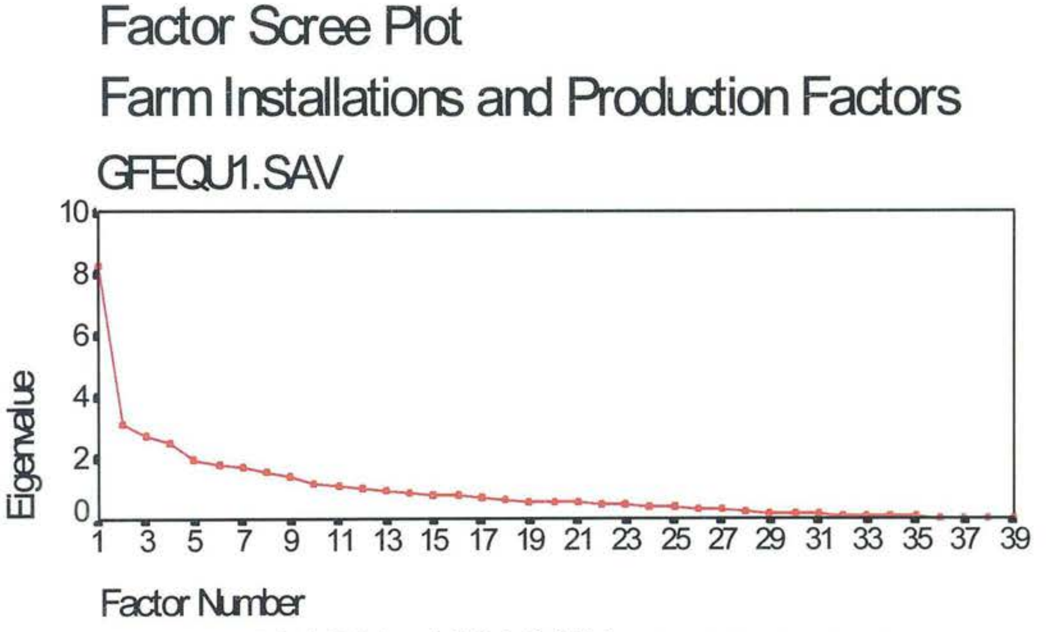
Variable	Communality	*	Factor	Eigenvalue	Pct of Var	Cum Pct
PRE1_58	1.00000	*	34	.28992	.6	96.8
PRE1_59	1.00000	*	35	.25584	.6	97.4
PRE1_60	1.00000	*	36	.23569	.5	97.9
PRE1_61	1.00000	*	37	.19568	.4	98.3
PRE1_62	1.00000	*	38	.19175	.4	98.8
PRE1_63	1.00000	*	39	.15327	.3	99.1
PRE1_63A	1.00000	*	40	.12344	.3	99.4
PRE1_63B	1.00000	*	41	.11141	.2	99.6
PRE1_63C	1.00000	*	42	.10364	.2	99.8
PRE1_65	1.00000	*	43	.07393	.2	100.0
PRE1_66	1.00000	*	44	.00327	.0	100.0
PRE1_67	1.00000	*	45	.00273	.0	100.0
PRE1_68	1.00000	*	46	.00146	.0	100.0

7.7 Farm installations and production indicators factors



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Extraction 1 for analysis 1, Principal Components Analysis (PC)

Initial Statistics:

Variable	Communality	*	Factor	Eigenvalue	Pct of Var	Cum Pct
		*				
PRE1_15	1.00000	*	1	8.28621	21.2	21.2
PRE1_16	1.00000	*	2	3.11044	8.0	29.2
PRE1_17	1.00000	*	3	2.72498	7.0	36.2
PRE1_19	1.00000	*	4	2.46858	6.3	42.5
PRE1_20	1.00000	*	5	1.99103	5.1	47.6
PRE1_21	1.00000	*	6	1.77706	4.6	52.2
PRE1_22A	1.00000	*	7	1.71811	4.4	56.6
PRE1_22B	1.00000	*	8	1.58348	4.1	60.7
PRE1_22C	1.00000	*	9	1.42241	3.6	64.3
PRE1_22D	1.00000	*	10	1.22404	3.1	67.5
PRE1_22E	1.00000	*	11	1.09596	2.8	70.3
PRE1_22F	1.00000	*	12	1.02593	2.6	72.9
PRE1_22G	1.00000	*	13	.96376	2.5	75.4
PRE1_22H	1.00000	*	14	.87645	2.2	77.6
PRE1_22I	1.00000	*	15	.81816	2.1	79.7
PRE1_22J	1.00000	*	16	.77759	2.0	81.7
PRE1_22K	1.00000	*	17	.74858	1.9	83.6

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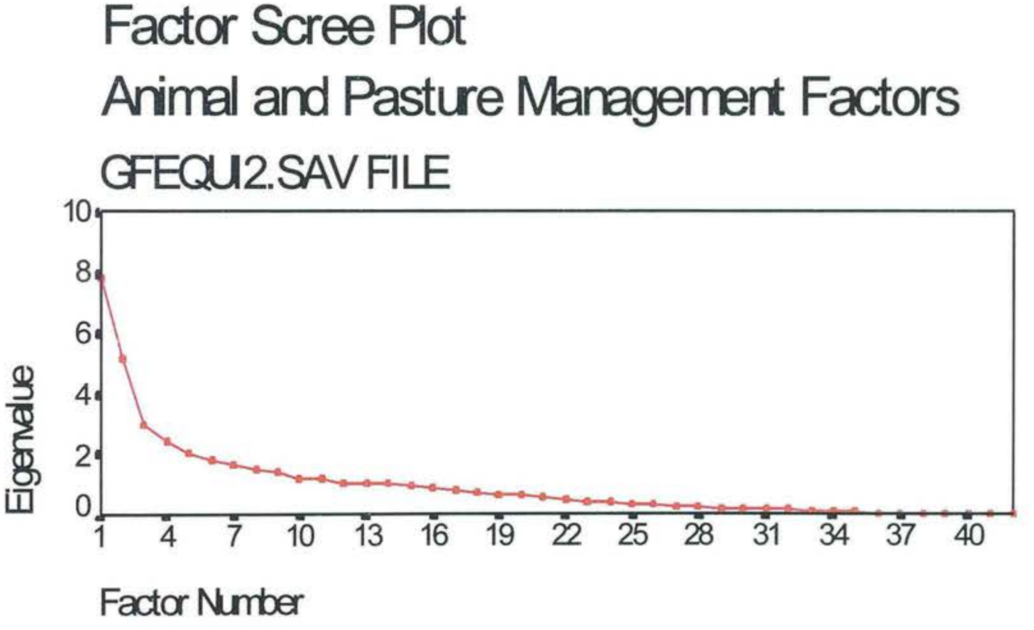
Variable	Communality	*	Factor	Eigenvalue	Pct of Var	Cum Pct
PRE1_22L	1.00000	*	18	.64333	1.6	85.3
PRE1_22M	1.00000	*	19	.59635	1.5	86.8
PRE1_22N	1.00000	*	20	.58395	1.5	88.3
PRE1_22O	1.00000	*	21	.55470	1.4	89.7
PRE1_22P	1.00000	*	22	.50776	1.3	91.0
PRE1_23	1.00000	*	23	.49628	1.3	92.3
PRE1_24	1.00000	*	24	.46084	1.2	93.5
PRE1_29	1.00000	*	25	.40015	1.0	94.5
PRE1_30	1.00000	*	26	.33317	.9	95.4
PRE1_32	1.00000	*	27	.31607	.8	96.2
PRE1_32A	1.00000	*	28	.28964	.7	96.9
PRE1_32B	1.00000	*	29	.21279	.5	97.5
PRE1_32C	1.00000	*	30	.18167	.5	97.9
PRE1_32D	1.00000	*	31	.16320	.4	98.3
PRE1_32E	1.00000	*	32	.14773	.4	98.7
PRE1_32F	1.00000	*	33	.12312	.3	99.0
PRE1_32G	1.00000	*	34	.10751	.3	99.3
PRE1_32H	1.00000	*	35	.08438	.2	99.5
PRE1_32I	1.00000	*	36	.07010	.2	99.7
PRE1_32K	1.00000	*	37	.06648	.2	99.9
PRE1_34B	1.00000	*	38	.03489	.1	100.0
PRE1_39	1.00000	*	39	.01309	.0	100.0

7.8. Animal and pasture management factors



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Extraction 1 for analysis 1, Principal Components Analysis (PC)

Initial Statistics:

Variable	Communality	*	Factor	Eigenvalue	Pct of Var	Cum Pct
		*				
PRE2_102	1.00000	*	1	7.83600	18.7	18.7
PRE2_103	1.00000	*	2	5.18726	12.4	31.0
PRE2_104	1.00000	*	3	2.99758	7.1	38.1
PRE2_105	1.00000	*	4	2.48203	5.9	44.1
PRE2_106	1.00000	*	5	2.07041	4.9	49.0

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Variable	Communality	*	Factor	Eigenvalue	Pct of Var	Cum Pct
PRE2_107	1.00000	*	6	1.84376	4.4	53.4
PRE2_108	1.00000	*	7	1.68308	4.0	57.4
PRE2_111	1.00000	*	8	1.53423	3.7	61.0
PRE2_112	1.00000	*	9	1.41904	3.4	64.4
PRE2_118	1.00000	*	10	1.22328	2.9	67.3
PRE2_119	1.00000	*	11	1.21839	2.9	70.2
PRE2_120	1.00000	*	12	1.08492	2.6	72.8
PRE2_121	1.00000	*	13	1.04251	2.5	75.3
PRE2_130	1.00000	*	14	1.01727	2.4	77.7
PRE2_131	1.00000	*	15	.99572	2.4	80.1
PRE2_132	1.00000	*	16	.92211	2.2	82.3
PRE2_133	1.00000	*	17	.82787	2.0	84.3
PRE2_134	1.00000	*	18	.75288	1.8	86.0
PRE2_135	1.00000	*	19	.67297	1.6	87.6
PRE2_136	1.00000	*	20	.63390	1.5	89.2
PRE2_137	1.00000	*	21	.55329	1.3	90.5
PRE2_69	1.00000	*	22	.50902	1.2	91.7
PRE2_72	1.00000	*	23	.42691	1.0	92.7
PRE2_73	1.00000	*	24	.41912	1.0	93.7
PRE2_74	1.00000	*	25	.36155	.9	94.6
PRE2_75	1.00000	*	26	.31497	.7	95.3
PRE2_76	1.00000	*	27	.30940	.7	96.0
PRE2_76A	1.00000	*	28	.27453	.7	96.7
PRE2_76B	1.00000	*	29	.22266	.5	97.2
PRE2_76C	1.00000	*	30	.22149	.5	97.8
PRE2_76D	1.00000	*	31	.17382	.4	98.2
PRE2_76E	1.00000	*	32	.16439	.4	98.6
PRE2_90	1.00000	*	33	.12450	.3	98.9
PRE2_91	1.00000	*	34	.11510	.3	99.1
PRE2_92	1.00000	*	35	.10135	.2	99.4
PRE2_93	1.00000	*	36	.07057	.2	99.5
PRE2_94	1.00000	*	37	.06438	.2	99.7
PRE2_95	1.00000	*	38	.04944	.1	99.8
PRE2_96	1.00000	*	39	.03481	.1	99.9
PRE2_97	1.00000	*	40	.02080	.0	99.9
PRE2_98	1.00000	*	41	.01465	.0	100.0
PRE2_99	1.00000	*	42	.00803	.0	100.0

Appendix 7.C.

Summary of Cluster Analysis results.

* * * * * * * * * * * * * * * P R O X I M I T I E S * * * * * * * * * * * * * * *

Data Information

81 unweighted cases accepted.
0 cases rejected because of missing value.

Squared Euclidean measure used.

* * * * * * H I E R A R C H I C A L   C L U S T E R   A N A L Y S I S * * * * * *

Agglomeration Schedule using Ward Method

Stage	Clusters Combined Cluster 1	Cluster 2	Coefficient	Stage Cluster 1st Appears Cluster 1	Cluster 2	Next Stage
1	38	51	26.005463	0	0	5
2	34	40	58.612881	0	0	19
3	50	54	91.596191	0	0	21
4	3	56	125.570351	0	0	12
5	38	68	159.692307	1	0	14
6	57	63	194.023972	0	0	37
7	44	53	229.907059	0	0	21
8	1	33	267.591522	0	0	17
9	42	48	305.651245	0	0	13
10	14	23	345.688232	0	0	23
11	10	59	386.069153	0	0	33
12	3	32	427.002533	4	0	18
13	18	42	468.717255	0	9	40
14	38	55	510.614532	5	0	24
15	2	27	553.416687	0	0	37
16	64	70	596.433960	0	0	42
17	1	60	639.863281	8	0	33
18	3	8	683.639343	12	0	35
19	29	34	728.423706	0	2	31
20	25	49	774.459778	0	0	41
21	44	50	821.538147	7	3	24
22	30	35	868.621460	0	0	25
23	14	17	916.381165	10	0	44
24	38	44	965.310608	14	21	35
25	30	36	1014.733704	22	0	49
26	16	22	1064.638306	0	0	46
27	43	47	1115.500854	0	0	53
28	9	20	1167.861328	0	0	40
29	58	69	1222.098267	0	0	44
30	13	21	1278.842896	0	0	43
31	28	29	1336.682495	0	19	55
32	41	61	1394.709961	0	0	49
33	1	10	1452.747437	17	11	36
34	4	74	1513.152344	0	0	65
35	3	38	1573.735107	18	24	54
36	1	80	1634.782471	33	0	48
37	2	57	1696.214355	15	6	47
38	62	79	1758.562256	0	0	42
39	26	72	1820.973511	0	0	60
40	9	18	1884.061523	28	13	53
41	25	67	1947.823608	20	0	48
42	62	64	2011.998901	38	16	56
43	12	13	2077.338135	0	30	50
44	14	58	2144.076660	23	29	64

* * * * * * H I E R A R C H I C A L   C L U S T E R   A N A L Y S I S * * * * * *

Agglomeration Schedule using Ward Method (CONT.)

	Clusters Combined			Stage Cluster 1st Appears		Next
Stage	Cluster 1	Cluster 2	Coefficient	Cluster 1	Cluster 2	Stage
45	11	45	2212.247070	0	0	51
46	7	16	2281.216064	0	26	57
47	2	78	2351.621094	37	0	54
48	1	25	2422.812744	36	41	58
49	30	41	2494.704834	25	32	64
50	12	76	2569.158936	43	0	62
51	6	11	2644.082031	0	45	57
52	46	66	2720.582764	0	0	63
53	9	43	2797.468018	40	27	63
54	2	3	2875.023438	47	35	59
55	28	81	2957.101074	31	0	61
56	39	62	3042.845215	0	42	68
57	6	7	3128.731201	51	46	65
58	1	5	3216.930420	48	0	66
59	2	73	3312.382568	54	0	61
60	26	71	3409.940430	39	0	70
61	2	28	3508.496826	59	55	68
62	12	15	3607.757080	50	0	69
63	9	46	3710.239258	53	52	72
64	14	30	3816.640137	44	49	67
65	4	6	3923.065918	34	57	77
66	1	52	4031.067139	58	0	71
67	14	31	4145.632324	64	0	72
68	2	39	4261.311523	61	56	71
69	12	77	4381.912109	62	0	77
70	26	65	4510.210938	60	0	75
71	1	2	4638.750488	66	68	76
72	9	14	4768.847656	63	67	74
73	19	24	4902.307617	0	0	79
74	9	75	5039.667969	72	0	78
75	26	37	5178.869141	70	0	76
76	1	26	5330.639648	71	75	80
77	4	12	5485.166016	65	69	78
78	4	9	5653.211914	77	74	79
79	4	19	5831.989258	78	73	80
80	1	4	6079.999512	76	79	0

Appendix 7.D.

Summary of Discriminant Analysis results.

- - - - - - - - D I S C R I M I N A N T   A N A L Y S I S - - - - - - - -

On groups defined by NEWCLUS

79 (Unweighted) cases were processed.
0 of these were excluded from the analysis.
79 (Unweighted) cases will be used in the analysis.

Number of cases by group

NEWCLUS	Number of cases Unweighted	Weighted	Label
1	44	44.0	
2	14	14.0	
3	21	21.0	
Total	79	79.0	

Wilks' Lambda (U-statistic) and univariate F-ratio
with 2 and 76 degrees of freedom

Variable	Wilks' Lambda	F	Significance
AREA_CUL	.94445	2.2351	.1140
AREA_MEJ	.74079	13.2963	.0000
EDAD_52_	.91008	3.7547	.0279
EDADMEN	.88844	4.7718	.0112
EDUCA_52	.92840	2.9308	.0594
P15_5	.73147	13.9500	.0000
P58_1_1	.99012	.3792	.6857
PRE1_23	.67753	18.0863	.0000
PRE1_29	.92101	3.2590	.0439
PRE1_30	.64718	20.7167	.0000
PRE1_39	.93209	2.7684	.0691
PRE2_104	.98197	.6976	.5010
PRE2_107	.99345	.2505	.7790
PRE2_74	.85061	6.6739	.0021
PREG166_	.66149	19.4464	.0000
PREG58_2	.98862	.4375	.6473
PREG_10	.98319	.6499	.5250
PREG_101	.79792	9.6240	.0002
PREG_124	.91896	3.3509	.0403
PREG_17	.92511	3.0762	.0519
PREG_177	.93264	2.7444	.0707
PREG_18	.84669	6.8808	.0018
PREG_19	.71192	15.3767	.0000
PREG_20	.77541	11.0066	.0001
PREG_30	.94639	2.1524	.1232
PREG_33	.80073	9.4567	.0002
PREG_34	.88872	4.7579	.0113
PREG_42	.92445	3.1057	.0505
PREG_44	.72704	14.2666	.0000
PREG_55	.96697	1.2981	.2790
PREG_56	.94507	2.2086	.1169
PREG_64	.80217	9.3718	.0002
PREG_69	.99395	.2313	.7940
PREG_71	.87243	5.5564	.0056
PREG_73	.94052	2.4032	.0973
PREG_76	.92699	2.9928	.0561
PREG_82	.93308	2.7254	.0719
PREG_83	.92866	2.9191	.0601
PREG_86	.82490	8.0661	.0007
PREG_91	.82376	8.1298	.0006

PREG_94	.82664	7.9694	.0007
PREG_95	.84209	7.1260	.0015
TOTHIJOS	.99267	.2806	.7561
ZONA	.81421	8.6710	.0004

- - - - - - - - D I S C R I M I N A N T   A N A L Y S I S - - - - - - - -

On groups defined by NEWCLUS

Analysis number 1

Direct method: all variables passing the tolerance test are entered.

Minimum tolerance level.................. .00100

Canonical Discriminant Functions

Maximum number of functions.............. 2
Minimum cumulative percent of variance... 100.00
Maximum significance of Wilks' Lambda.... 1.0000

Prior probability for each group is .33333

Canonical Discriminant Functions

Fcn	Eigenvalue	Pct of Variance	Cum Pct	Canonical Corr	:	After Fcn	Wilks' Lambda	Chi-square	df	Sig
					:	0	.053586	159.493	88	.0000
1*	4.4955	65.23	65.23	.9045	:	1	.294480	66.629	43	.0119
2*	2.3958	34.77	100.00	.8400	:					

* Marks the 2 canonical discriminant functions remaining in the analysis.

Structure matrix:

Pooled within-groups correlations between discriminating variables
and canonical discriminant functions
(Variables ordered by size of correlation within function)

	Func 1	Func 2
PRE1_30	.32712*	.16362
PRE1_23	.32268*	.05735
PREG_19	.29043*	.10310
P15_5	.26521*	.14578
PREG_101	.23199*	.06875
PREG_20	.22750*	.15422
PREG_64	-.22288*	-.09864
PREG_91	.21313*	.06375
PREG_33	-.20236*	.16442
PREG_71	-.17415*	.06424
PRE2_74	.16984*	-.13849
PREG_18	.16667*	.15316
EDADMEN	-.16666*	-.01714
EDAD_52_	-.12767*	-.10322
PREG_76	.12643*	-.05365
PREG_83	-.12493*	.05272
EDUCA_52	.11880*	-.07558
PREG_73	-.11846*	.00801
PREG_17	.11816*	.08713
PREG_177	-.11414*	-.07550
PREG_44	-.18976	.29856*
PREG166_	-.26071	.29336*
AREA_MEJ	.18447	-.28669*
PREG_95	.11417	-.23198*
ZONA	.15564	-.22314*
PREG_94	-.14932	.21378*
PREG_86	-.16541	.19303*
PREG_42	-.00279	-.18466*
PRE1_29	-.04757	.17763*
PREG_124	-.07010	-.16609*
PREG_82	-.05072	.15846*
PRE1_39	.05458	.15754*
PREG_56	.02842	.15081*
PREG_34	.13303	-.13803*
PREG_55	.02667	-.11369*
AREA_CUL	.08900	-.09843*
PREG_30	-.09014	.09163*
PRE2_104	.01961	.08331*
PREG_10	.01447	-.08213*
TOTHIJOS	-.01693	-.05044*
PRE2_107	.01642	.04739*
PREG58_2	-.03812	-.04560*
P58_1_1	-.03595	-.04172*
PREG_69	.02697	.03429*

* denotes largest absolute correlation between each variable and any discriminant function.

Canonical discriminant functions evaluated at group means (group centroids)

Group	Func 1	Func 2
1	-1.73575	.47723
2	.83342	-3.21416
3	3.08119	1.14287

Case Number	Mis Val	Sel	Actual Group	Highest Probability Group	P(D/G)	P(G/D)	2nd Highest Group	P(G/D)	Discrim Scores
1			1	1	.0145	1.0000	3	.0000	-2.7967 3.1863
2			1	1	.3645	.9914	3	.0059	-.3235 .3228
3			1	1	.5537	.9978	3	.0012	-.6538 .3689
4			2	2	.3891	1.0000	3	.0000	2.1888 -3.4390
5			1	1	.7176	.9998	2	.0002	-2.1618 -.2171
6			2	2	.4718	1.0000	1	.0000	1.0086 -4.4273
7			2	2	.7875	1.0000	1	.0000	.5621 -3.8499
8			1	1	.6736	1.0000	2	.0000	-2.5952 .7047
9			3	3	.3410	.9915	2	.0077	2.2929 -.0942
10			1	1	.6834	.9990	2	.0005	-.8666 .4005
11			2	2	.4593	.9996	3	.0004	2.0390 -2.8935
12			2	2	.7364	.9998	3	.0002	1.4515 -2.7348
13			2	2	.1183	.8349	1	.1651	-.9337 -2.1434
14			3	3	.7089	.9995	1	.0003	2.3846 .6925
15			2	2	.9445	.9999	1	.0001	.5050 -3.2934
16			2	2	.6630	.9997	3	.0003	1.6168 -2.7578
17			3	3	.1622	1.0000	2	.0000	4.8733 .4898
18			3	3	.8665	1.0000	1	.0000	3.0705 1.6781
19			3	3	.4047	1.0000	1	.0000	3.6536 2.3601
20			2	2	.8283	1.0000	1	.0000	.5230 -3.7438
21			2	2	.2490	.9984	1	.0016	-.8261 -3.3771
22			3	3	.3571	.9999	2	.0001	3.9313 -.0132
23			1	1	.7899	.9996	2	.0004	-1.8460 -.2006
24			1	1	.9962	.9999	2	.0000	-1.6517 .5003
25			1	1	.3265	.9994	3	.0006	-1.0099 1.7855
26			1	1	.7402	1.0000	3	.0000	-1.8688 1.2414
27			1	1	.6893	1.0000	2	.0000	-2.3647 1.0676
28			3 **	1	.0625	.5908	3	.4065	.5939 .8188
29			3	3	.4312	1.0000	1	.0000	2.5631 2.3321
30			1	1	.1719	.8964	2	.0981	-.1908 -.5880
31			1	1	.6595	.9991	2	.0009	-1.8233 -.4310
32			1	1	.8763	1.0000	3	.0000	-1.6567 .9850
33			3	3	.4531	1.0000	2	.0000	4.1600 1.7905
34			3	3	.1005	1.0000	1	.0000	3.7092 3.1926

Case Number	Mis Val	Sel	Actual Group		Highest Probability Group	P(D/G)	P(G/D)	2nd Highest Group	P(G/D)	Discrim Scores
35			1		1	.9627	.9999	2	.0001	-1.7438
										.2016
36			1		1	.7624	.9990	2	.0010	-1.4639
										-.2074
37			1		1	.4178	.9989	2	.0011	-2.2205
										-.7519
38			1		1	.9429	1.0000	2	.0000	-1.9307
										.7592
39			3		3	.6900	.9995	2	.0004	2.5275
										.4829
40			3		3	.4602	.9970	2	.0026	2.3881
										.1076
41			3		3	.6038	1.0000	1	.0000	3.6751
										1.9531
42			1		1	.8482	.9995	2	.0004	-1.6014
										-.0806
43			2		2	.7521	1.0000	3	.0000	1.4898
										-3.5868
44			3		3	.1803	1.0000	2	.0000	4.9081
										.8456
45			3	**	1	.2887	.9566	2	.0427	-.6469
										-.6627
46			3		3	.4360	1.0000	1	.0000	3.3584
										2.4012
47			1		1	.5422	.9966	2	.0034	-1.5897
										-.6196
48			1		1	.5589	1.0000	3	.0000	-1.7359
										1.5559
49			1		1	.4295	.9951	3	.0039	-.4362
										.5146
50			1		1	.9044	1.0000	2	.0000	-1.9751
										.8563
51			1		1	.3887	1.0000	2	.0000	-3.0627
										.8365
52			1		1	.3472	.9999	3	.0001	-1.4858
										1.9102
53			1		1	.2571	.9942	2	.0058	-2.1072
										-1.1286
54			1		1	.7452	1.0000	3	.0000	-2.0254
										1.1873
55			1		1	.3618	.9819	2	.0170	-.5822
										-.3610
56			3		3	.4624	1.0000	1	.0000	3.8698
										2.1025
57			1		1	.2114	1.0000	3	.0000	-2.7389
										1.9270
58			1		1	.7729	1.0000	2	.0000	-2.4517
										.4254
59			3		3	.9830	1.0000	2	.0000	3.2602
										1.0951
60			1		1	.0839	.9999	2	.0001	-3.5288
										-.8428
61			1		1	.0493	1.0000	2	.0000	-3.7866
										1.8242
62			1		1	.3315	.9999	3	.0001	-1.4250
										1.9303
63			1		1	.2314	1.0000	3	.0000	-2.3357
										2.0794
64			3		3	.5571	1.0000	1	.0000	3.9575
										1.7772
65			1		1	.4220	.9967	3	.0032	-.5545
										1.0519
66			1		1	.3464	.9861	2	.0139	-1.5301
										-.9644
67			3		3	.6451	.9997	2	.0003	3.1851
										.2123
68			1		1	.5118	.9928	2	.0070	-.9619
										-.3835

Case Number	Mis Val	Sel	Actual Group	Highest Probability Group	P(D/G)	P(G/D)	2nd Highest Group	P(G/D)	Discrim Scores
69			1	1	.5415	.9942	2	.0057	-1.0012
									-.3518
70			1	1	.8138	.9996	2	.0002	-1.0955
									.4309
71			1	1	.2388	.9420	2	.0579	-1.1828
									-1.1222
72			2	2	.0948	.7387	1	.2449	.3752
									-1.0924
73			3	3	.7770	.9998	2	.0002	2.9895
									.4384
74			2	2	.4905	1.0000	3	.0000	1.8242
									-3.8796
75			2	2	.5223	.9999	1	.0001	-.1563
									-3.7794
76			1	1	.3160	.9769	2	.0231	-1.3750
									-.9971
77			1	1	.3252	1.0000	3	.0000	-2.0847
									1.9349
78			1	1	.9458	.9998	2	.0002	-1.4712
									.2734
79			1	1	.3588	1.0000	2	.0000	-3.0796
									-.0168

Classification results -

Actual Group	No. of Cases	Predicted Group Membership 1	2	3
Group 1	44	44	0	0
		100.0%	.0%	.0%
Group 2	14	0	14	0
		.0%	100.0%	.0%
Group 3	21	2	0	19
		9.5%	.0%	90.5%

Percent of "grouped" cases correctly classified: 97.47%

Classification processing summary

79 (Unweighted) cases were processed.
0 cases were excluded for missing or out-of-range group codes.
0 cases had at least one missing discriminating variable.
79 (Unweighted) cases were used for printed output.

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Appendix 8. (Chapter 8; Quantitative data)

Table 8.1. Case 1, summary of quantitative information.

Case 1 Overall indicators	1989	1990	1991	1992	1993	1994
Land use						
Natural grasslands	2575	2575	2575	2575	2575	2575
Improved pastures	0	0	0	0	0	13
Total	2575	2575	2575	2575	2575	2588
Beef cattle stock	1276	1038	1132	1349	1414	1454
Animal units	1022.3	918.8	899.5	962.1	1022.5	1074.3
Average calving percentage	45	41	64	75	65	57
AU/ha	0.40	0.36	0.35	0.37	0.40	0.42
Sheep stock	4697	5069	5530	5848	5201	5627
Animal units	939.4	1019.8	1106	1169.6	1040.2	1122.4
Average lambing percentage	75	79	75	78	72	63
AU/ha	0.36	0.40	0.43	0.45	0.40	0.43
Horses stock	53	62	73	72	61	63
Animal Units	64	74	88	86	73	76
AU/ha	0.02	0.02	0.03	0.03	0.02	0.02
Technical coefficients						
Average UA/ha	0.78	0.78	0.81	0.86	0.82	0.87
Average sheep/cattle	3.68	4.88	4.89	4.34	3.68	3.87
Cattle						
Mortality %	19.10	18.99	2.32	3.30	3.90	2.12
Consumption %	0.00	0.00	0.09	0.00	0.00	0.07
Sheep						
Mortality %	13.99	4.76	6.61	5.71	7.03	5.30
Consumption %	5.21	6.08	5.01	4.19	4.15	3.62
Farm labor						
Family	3	3	3	3	3	3
Salaried	2	2	2	2	2	2
Wool production						
Wool Kg		16908	17657	18231	19045	18426
Kg/head		3.60	3.48	3.30	3.26	3.54
Kg/ha		6.57	6.86	7.08	7.40	7.16

Table 8.2. Case 1, summary of economic indicators.

Gross income	1990	1991	1992	1993	1994
Gross income					
Sales					
Cattle US$	14102	27560	21850	24459	48378
Sheep US$	3851	3591	2790	4450	3089
Wool US$	25798	24720	29169	25139	23954
Total gross income	43751	55871	53809	54048	75421
Gorss income/ha	16.99	21.70	20.90	20.99	29.14

Table 8.3. Case 2, summary of quantitative data.

Overall indicators	1989	1990	1991	1992	1993	1994
Land use						
Natural grasslands	3863	3843	3729	3729	3729	3729
Improved pastures	167	187	187	187	187	187
Total	4030	4030	3916	3916	3916	3916
Beef cattle	2303	2293	2527	2667	2901	2704
Animal units	1606.8	1822.3	1865.5	1855.4	2015.7	1976.4
Calving percentage	89	67	76	70	88	74
AU/ha	0.40	0.45	0.48	0.47	0.51	0.50
Sheep	4571	4582	4871	5744	5491	4223
Animal units	914.2	916.4	974.2	1148.8	1098.2	844.6
Calving percentage	69	70	102	96	83	81
AU/ha	0.23	0.23	0.25	0.29	0.28	0.22
Horses	101	90	86	86	90	90
Animal Units	121.20	108.00	103.20	103.20	108.00	108.00
AU/ha	0.03	0.02	0.02	0.02	0.02	0.02
Tota AU/ha	0.65	0.70	0.75	0.79	0.82	0.74
Sheep/Cattle ratio	1.98	2.00	1.93	2.15	1.89	1.56
Beef cattle out of the farm						
Agist			391	297	808	482
Cattle						
Mortality %	2.56	2.78	2.80	3.27	3.40	2.10
Consumption %	0.00	0.00	0.00	0.00	0.00	2.70
Sheep						
Mortality %	7.80	7.90	7.90	6.00	7.79	2.40
Consumption %	3.59	6.37	5.67	7.30	7.25	0.99
Farm labor						
Family	2	2	2	2	2	2
Salaried	6	7	5	6	6	5
Wool production						
Wool Kg		22241	19541	15574	17778	19315
Kg/head		4.85	4.01	2.71	3.24	4.57
Kg/ha		5.52	4.99	3.98	4.54	4.93

Table 8.4. Case 2, summary of economic information.

	1990	1991	1992	1993	1994
Gross income					
Cattle US$	47461	103541	125080	112298	141544
Leather US$	911.97	580.49	442.68	305.72	726.25
Sheep US$	9935	8816.7	6550	12826	19315
Wool US$	44093	25084	32113	37280	20285
Total gross income	102401	138022	164186	162709	181870
Gross income/ha	25.41	35.25	41.93	41.55	46.44
Production cost/ha	17.76	18.33	22.06	28.09	27.38
Net income/ha	7.65	16.92	19.86	13.46	19.06
Cost /benefit ratio	0.70	0.52	0.53	0.68	0.59

Table 8.5. Case 3, summary of quantitative information.

Overall indicators	1989	1990	1991	1992	1993	1994
Land use						
Natural grasslands	4852	4734	4734	4734	4676	4429
Improved pastures	80	198	198	198	256	443
Weath						60
Total	4932	4932	4932	4932	4932	4932
Dairy farm	197	197	197	197	197	197
Hired rice land					280	280
Hired grazing lands (has)	965	965	965	965	457	1924
Total land	6094	6094	6094	6244	5736	7313
Main farm						
Beef cattle	1234	2187	2417	2897	2812	3565
Animal units	859	1712.6	1809.4	2046.4	1918	2713.6
Calving percentage		77	86	79	69	75
AU/ha	0.17	0.35	0.37	0.41	0.39	0.55
Sheep	5592	9209	11390	10645	10869	10709
Animal units	1118.4	1548	1776.4	1881.4	1894.2	1843.3
Calving percentage		79	67	72	79	76
AU/ha	0.23	0.31	0.36	0.38	0.38	0.37
Horses						
Animal Units	43	43	45	45	46	48
AU/ha	51.6	51.6	54	54	55.2	57.6
Tota AU/ha	0.41	0.67	0.74	0.81	0.78	0.94
Sheep/Cattle ratio	4.53	4.21	4.71	3.67	3.87	3.00
Cattle						
Mortality %	7.4	8.9	2.6	3.7	3.2	2.4
Consumption %	0	0	0	0	0	0
Sheep						
Mortality %	12.5	10.5	6.4	7.1	7.3	6.2
Consumption %	7.1	6.7	5.8	7.3	7.6	8.8

Table 8.5 (cont.) Case 3, summary of quantitative information.

	1989	1990	1991	1992	1993	1994
Animals in hired land						
Number of beef cattle	140	181	217	164	395	
Animal units	137	141	217	164	317.4	
Number of sheep	4514	3336	4107	2768		
Animal units	723.3	667.2	821.4	553.6		
Agist animals						
Beef cattle	529	19				
Dairy farm						
Dairy cattle	145	167	201	234	219	252
Animal units	113.4	135	149.6	177.2	149.2	159.6
Total number of						
Beef cattle	2048	2554	2835	3295	3426	3817
Sheep	10106	12545	15497	13413	10869	10709
Sheep/cattle ratio	4.93	4.91	5.47	4.07	3.17	2.81
Farm Labor						
Family	1	1	1	1	1	1
Salaried	15	18	17	15	25	26
Production indicators						
Wool Kg		44312	43758	39949	33913	31371
Wool Kg/head		3.7623	3.2811	3.1721	3.3954	3.2341
Wool Kg/ha		7.5143	7.4204	6.7745	6.293	4.5757
Cash crops						
Rice production (Tons.)					2324	2240
Kg /ha					8300	8000